**Instruction Manual**
PN 51-TCL54e/rev.B
May 2007

Model TCL

# Total Chlorine Analyzer

ROSEMOUNT® Analytical

EMERSON™ Process Management

# ESSENTIAL INSTRUCTIONS

## READ THIS PAGE BEFORE PROCEEDING!

Rosemount Analytical designs, manufactures, and tests its products to meet many national and international standards. Because these instruments are sophisticated technical products, you must properly install, use, and maintain them to ensure they continue to operate within their normal specifications. The following instructions must be adhered to and integrated into your safety program when installing, using, and maintaining Rosemount Analytical products. Failure to follow the proper instructions may cause any one of the following situations to occur: Loss of life; personal injury; property damage; damage to this instrument; and warranty invalidation.

- Read all instructions prior to installing, operating, and servicing the product. If this Instruction Manual is not the correct manual, telephone 1-800-654-7768 and the requested manual will be provided. Save this Instruction Manual for future reference.
- If you do not understand any of the instructions, contact your Rosemount representative for clarification.
- Follow all warnings, cautions, and instructions marked on and supplied with the product.
- Inform and educate your personnel in the proper installation, operation, and maintenance of the product.
- Install your equipment as specified in the Installation Instructions of the appropriate Instruction Manual and per applicable local and national codes. Connect all products to the proper electrical and pressure sources.
- To ensure proper performance, use qualified personnel to install, operate, update, program, and maintain the product.
- When replacement parts are required, ensure that qualified people use replacement parts specified by Rosemount. Unauthorized parts and procedures can affect the product's performance and place the safe operation of your process at risk. Look alike substitutions may result in fire, electrical hazards, or improper operation.
- Ensure that all equipment doors are closed and protective covers are in place, except when maintenance is being performed by qualified persons, to prevent electrical shock and personal injury.

## WARNING
## ELECTRICAL SHOCK HAZARD

Making cable connections to and servicing this instrument require access to shock hazard level voltages which can cause death or serious injury.

Be sure to disconnect all hazardous voltage before opening the enclosure.

Relay contacts made to separate power sources must be disconnected before servicing.

Electrical installation must be in accordance with the National Electrical Code (ANSI/NFPA-70) and/or any other applicable national or local codes.

Unused cable conduit entries must be securely sealed by non-flammable closures to provide enclosure integrity in compliance with personal safety and environmental protection requirements.

The unused conduit openings need to be sealed with NEMA 4X or IP65 conduit plugs to maintain the ingress protection rating (IP65).

For safety and proper performance this instrument must be connected to a properly grounded three-wire power source.

Proper relay use and configuration is the responsibility of the user.

No external connection to the instrument of more than 69VDC or 43V peak allowed with the exception of power and relay terminals. Any violation will impair the safety protection provided

Do not operate this instrument without front cover secured. Refer installation, operation and servicing to qualified personnel.

## WARNING

This product is not intended for use in the light industrial, residential or commercial environment, per the instrument's certification to EN50081-2.

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EMERSON Process Management

**WARNING**

**HAZARDOUS VOLTAGE**

Can cause severe injury or death. Disconnect power before servicing.

**VYSTRAHA**

**NEBEZPECNE NAPETI**

Muze zpusobit vazne zraneni nebo smrt. Odpojte napajeni pred udrzbou.

**AVISO**

**VOLTAJE PELIGROSO**

Puede causar severas lesiones o muerte. Desconecte la alimentación antes del mantenimiento.

**ADVARSEL**

**FARLIG SPÆNDING**

Kan forårsage alvorlige kvæstelser eller død.

Afbryd spænding før servicering.

**ATTENTION**

**HAUTE TENSION**

Peut provoquer des blessures graves ou la mort. Déconnecter l'alimentation avant manipulation.

**OSTRZEZENIE**

**NIEBEZPIECZNE NAPIECIE**

Moze spowodowac uszkodzenie ciala lub smierc.Odlacz zasilanie przed przystapieniem do prac.

**WARNUNG**

**GEFAEHRLICHE SPANNUNG**

Am Geraet liegt eine gefaehrliche Spannung an. Schalten Sie immer vor dem Oeffnen des Geraetes alle Zuleitungen spannungsfrei.

**Waarschuwing**

**GEVAARLIJKE SPANNING**

Kan ernstig of dodelijk letsel veroorzaken. Schakel de voeding uit voordat u onderhoudswer kzaamheden uitvoert.

**Attenzione**

**ALTA TENSIONE**

Può causare grave lesione o morte. Disattivare le tensioni prima di effettuare la manutenzione.

**ADVARSEL**

**FARLIG SPENNING**

Kan føre til alvorlige skader eller dødsulykker. Spenningstilførsel må frakobles før service utføres.

**VARNING**

**LIVSFARLIG SPÄNNING**

Kan medföra allvarlig skada eller dödsfall.

Bryt spänning innan service utföres.

**AVISO**

**TENSÃO PERIGOSA**

Pode causar lesões graves ou a morte. Desligar a energia antes de proceder a trabalhos de manutenção.

**DANGER**

**HAZARDOUS AREA INSTALLATION**

Installations near flammable liquids or in hazardous area locations must be carefully evaluated by qualified on site safety personnel. This device is not Intrinsically Safe or Explosion Proof.

To secure and maintain an intrinsically safe installation, the certified safety barrier, transmitter, and sensor combination must be used. The installation system must comply with the governing approval agency (FM, CSA or BASEEFA/CENELEC) hazardous area classification requirements. Consult your analyzer/transmitter instruction manual for details.

Proper installation, operation and servicing of this device in a Hazardous Area Installation is entirely the responsibility of the user.

**CAUTION**

**SENSOR/PROCESS APPLICATION COMPATIBILITY**

**Wetted materials may not be compatible with process composition and operating conditions. Application compatibility is entirely the responsibility of the user.**

## About This Document

This manual contains instructions for installation and operation of the Model TCL Total Chlorine Analyzer.

The following list provides notes concerning all revisions of this document.

| Rev. Level | Date | Notes |
|---|---|---|
| A | 7/05 | This is the initial release of the product manual. The manual has been reformatted to reflect the Emerson documentation style and updated to reflect any changes in the product offering. |
| B | 2/06 | Corrected typographical errors. Added statement to calibration section concerning initial stabilization time. |

# MODEL TCL
# TOTAL CHLORINE ANALYZER

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## LIST OF FIGURES

# SECTION 1. DESCRIPTION AND SPECIFICATIONS

**The Model TCL is intended for the determination of total chlorine in water, including the determination of chlorine in seawater. The system consists of a sample conditioning unit, a sensor, and a 54eA chlorine analyzer.**

## Model TCL Sample Conditioning System

- **CORROSION RESISTANT ALL PLASTIC CONSTRUCTION.** Ideal for seawater.
- **LOW SAMPLE FLOW** (about 20 mL/hour) means little waste.
- **REAGENT-BASED SYSTEM** measures true total chlorine.

## Model 54eA Analyzer

- **THREE LINE BACK-LIT DISPLAY** with easy to use interface
- **TWO INDEPENDENT OUTPUTS**
- **THREE FULLY PROGRAMMABLE ALARMS,** plus one dedicated fault alarm
- **OPTIONAL HART DIGITAL COMMUNICATIONS**
- **OPTIONAL PID AND TPC CONTROL**

## Model 499A CL-02 Sensor

- **RUGGED** molded Noryl[1] (PPO) construction.
- **NO TOOLS REQUIRED** to change membrane.
- **MAINTENANCE TAKES ONLY A FEW MINUTES** a month.

[1] Noryl is a registered trademark of General Electric.

## 1.1 FEATURES AND APPLICATIONS

### MODEL 54eA ANALYZER

The Model 54eA analyzer can be used with the TCL sample conditioning system and 499ACL-02 sensor for the continuous determination of chlorine in water.

The Model 54eA analyzer is housed in a rugged NEMA 4X weatherproof, corrosion resistant enclosure of epoxy-painted aluminum. It is suitable for panel, pipe, or wall mounting. Operation of the analyzer is through a front panel membrane keypad. The large back-lit dot matrix display continuously indicates chlorine concentration in large numerals along with temperature, current output, and two programmable process parameters, such as alarms or diagnostic variables. Menu screens for calibrating and programming the analyzer are simple and intuitive. Plain language prompts in English, Spanish, Italian, German, or French guide the user through instrument configuration and sensor calibration

The Model 54eA is a member of the Rosemount SMART FAMILY® of instruments. It is designed to communicate with the Model 375 HART® communicator or any host that supports the HART communication protocol.

Two independent isolated outputs provide either a 0-20 mA or 4-20 mA output and can be assigned to chlorine or temperature. The controller option allows PID control acting on chlorine or temperature.

Three, fully programmable process alarms are standard. One relay can be configured as an interval timer. An overfeed timer is available for any one process relay, and one relay can also be used as an interval timer. The TPC option allows any alarm relay to be used for Time Proportional Control.

The analyzer fully compensates chlorine readings for changes in membrane permeability caused by temperature changes.

For additional information, see Product Data Sheet 71-54e.

### MODEL 499A CL-02 SENSOR

The Model 499ACL-02 total chlorine sensor is used in the TCL sample conditioning system. Although the sensor is called a chlorine sensor, it really measures iodine. The iodine comes from the reaction between halogen oxidants in the sample and the acetic acid/potassium iodide reagent added by the sample conditioning system.

The sensor consists of a gold cathode and a silver anode in an electrolyte solution. A silicone membrane, permeable to iodine, is stretched over the cathode. The analyzer applies a voltage to the cathode sufficiently negative to reduce all the iodine reaching it. Because the concentration of iodine in the sensor is always zero, a concentration gradient continuously forces iodine from the sample through the membrane into the sensor.

The reduction of iodine in the sensor generates a current directly proportional to the diffusion rate of iodine through the membrane, which is directly proportional to the concentration of iodine in the sample. Because the iodine concentration depends on the amount of total chlorine in the sample, the sensor current is ultimately proportional to the total chlorine concentration.

The permeability of the membrane to iodine is a function of temperature. A Pt100 RTD in the sensor measures the temperature, and the analyzer uses the temperature to compensate the total chlorine reading for changes in membrane permeability.

Sensor maintenance is fast and easy. Replacing the membrane requires no special tools or fixtures. Simply place the membrane assembly on the cathode and screw the retainer in place. Installing a new membrane and replenishing the electrolyte takes only a few minutes.

## 1.2 SPECIFICATIONS — SAMPLE CONDITIONING SYSTEM

### GENERAL

**Enclosure:** Fiberglass reinforced polyester, NEMA 3 (IP53) suitable for marine environments

**Dimensions:** 14.5 x 13.0 x 8.6 in. (369 x 329 x 218 mm)

**Mounting:** Wall

**Ambient Temperature:** 32° - 122°F (0 - 50°C)

**Ambient Humidity:** 0 - 90% (non-condensing)

**Power:** 115 Vac, 6.9 W, 50/60 Hz;
230 Vac, 7.0 W, 50/60 Hz

**Hazardous Location:** The TCL sample conditioning system has no hazardous location approvals.

**Pumps:**
EN 809:1998

**Weight/Shipping Weight:** 14 lb/16 lb (6.5 kg/7.5 kg)

### SAMPLE REQUIREMENTS

**Inlet Connection:** compression fitting, accepts 1/4 in. OD tubing

**Drain Connection:** 3/4 in. barbed fitting (must drain to open atmosphere)

**Inlet Pressure:** <100 psig (791 kPa abs)

**Flow:** at least 0.25 gph (15 mL/min)

**Temperature:** 32 - 122°F (0 - 50°C)

**Total Alkalinity:** <300 mg/L as $CaCO_3$. For samples containing <50 mg/L alkalinity, consult the factory.

### SAMPLE CONDITIONING SYSTEM

**Reagent:** Potassium iodide in vinegar.

**Reagent Usage:** 5 gallons lasts approximately 60 days.

**Reagent Pump:** Fixed speed peristaltic pump, about 0.2 mL/min

**Sample Pump:** Fixed speed peristaltic pump, about 11 mL/min

## 1.3 SPECIFICATIONS — MODEL 54e-24 ANALYZER

**Case:** Epoxy-painted cast aluminum, NEMA4X (IP65).

**Dimensions:** 5.7 x 5.7 x 5.2 in. (144 x 144 x 132 mm), DIN size panel cut-out.

**Front Panel:** Membrane keypad with tactile feedback. Three green LEDs indicate alarm status. Red LED indicates fault condition.

**Conduit Openings:** Accepts PG 13.5 or 1/2 inch conduit fittings

**Display:** Three-line, back-lit, dot matrix LCD, 70 x 35 mm. First line is measurement reading. Second line is temperature and current output. Third line is user-selectable. Character heights: 1st line - 16 mm (0.6 in.), 2nd and 3rd lines - 7 mm (0.3 in.).

**Ambient Temperature and Humidity:** 0 to 50°C (32 to 122°F). 95% (maximum) non-condensing.

Analyzer can be operated between -20 and 60°C (-4 to 140°F) with some degradation in display quality.

**Power:** 100-127 Vac ± 10%, 50/60 Hz ± 6%, 8 W
200-253 Vac ± 10%, 50/60 Hz ± 6%, 8 W

**Hazardous Location:** Applies to analyzer only, not to system
Class I, Division 2, Groups A, B, C, & D.
T5 Ta=50°C. Dust ignition proof: Class II, Division 1, Groups E, F, & G; Class III.

FM: Max. relay contact rating: 28 Vdc resistive
150 mA - Groups A & B;
400 mA - Group C;
540 mA - Group D

APPROVED

CSA:
–LR 34186
Max. relay contact rating:
28 Vdc; 110 Vac; 230 Vac;
6 amps resistive. Enclosure Type 4.

**RFI/EMI:** EN-61326

**LVD:** EN-61010-1

**Outputs:** Two 4-20 mA or 0-20 mA isolated outputs. Continuously adjustable. Outputs can be assigned to chlorine or temperature. Output dampening is user-selectable. Maximum load at 115/230 Vac is 600Ω. Maximum load at 100/200 Vac is 550Ω. Output 1 has superimposed HART signal (options -261 and -263). Outputs can be programmed for PID control (options -262 and -263).

**Alarms:**

Relay 1 - Process, Interval, or Time Proportional Control (TPC requires code -262 or -263)

Relay 2 - Process, Interval, or Time Proportional Control (TPC requires code -262 or -263)

Relay 3 - Process, Interval, or Time Proportional Control (TPC requires code -262 or -263)

Relay 4 - Sensor/analyzer and process fault alarm

Each relay has a dedicated LED on the front panel.

**Relay Contacts:** Relays 1-3: Epoxy sealed form A contacts, SPST, normally open

Relay 4: Epoxy sealed form C, SPDT

| | Resistive | Inductive |
|---|---|---|
| 28 Vdc | 5.0 Amps | 3.0 Amps |
| 115 Vac | 5.0 Amps | 3.0 Amps |
| 230 Vac | 5.0 Amps | 1.5 Amps |

**Weight/Shipping Weight:** 5 lb/6 lb (2 kg/2.5 kg)

## 1.4 SPECIFICATIONS — MODEL 499ACL-02 SENSOR

**Wetted Parts:** Gold, Noryl®[1] (PPO), Viton®[2], EPDM, Silicone

**Dimensions:** 1.0 x 5.6 in. (25.4 x 143 mm)

**Cable:** 25 ft. (7.6m) standard

**Pressure Rating:** 0 to 65 psig (101 to 549 kPa)

**Temperature Rating:** 32 to 122°F (0 to 50°C)

**Electrolyte Capacity:** Approximately 25 mL

**Electrolyte Life:** Approximately 4 months

**Weight/Shipping Weight:** 1 lb/3 lb (0.5 kg/1.5 kg)

[1] Noryl is a registered trademark of General Electric.

[2] Viton is a registered trademark of DuPont Performance Elastomers.

## 1.5 PERFORMANCE SPECIFICATIONS — COMPLETE SYSTEM

**Linear Range:** 0 to 20 ppm (mg/L) as $Cl_2$ (for higher ranges, consult factory)

**Linearity (per ISO 15839):** 0-10 ppm: 2%; 0-20 ppm: 3%

**Response Time:** Following a step change in concentration, the reading reaches 90% of final value within 7 minutes at 25°C.

**Drift:** At about 1.5 ppm in clean water and constant temperature, drift is typically less 0.05 ppm over two weeks.

**Detection Limit (per ISO 15839):** 0.02 ppm (mg/L) in clean water at room temperature

## 1.6 ORDERING INFORMATION AND ACCESSORIES

**Model TCL Reagent-Based Chlorine System.** The TCL is used for the continuous determination of total chlorine in water. The TCL consists of a sample conditioning system, a reagent carboy, a sensor, and an analyzer. **Reagents must be ordered separately. Regent kits for 0-5 ppm and 0-10 ppm chlorine are available. For higher ranges, consult the factory.** See **ACCESSORIES - Sample Conditioning System**.

| MODEL TCL | REAGENT-BASED CHLORINE SYSTEM |
|---|---|
| **CODE** | **POWER (required selection)** |
| 11 | 115 V 50/60 Hz |
| 12 | 230 V 50/60 Hz |

| CODE | ANALYZER (optional selection) |
|---|---|
| 250 | 1055-01-10-24 analyzer, panel mount |
| 251 | 1055-01-11-24 analyzer, pipe/wall mount |
| 260 | 54eA-01 analyzer |
| 261 | 54eA-01-09 analyzer with HART communications |
| 262 | 54eA-01-20 controller with PID and TPC control |
| 263 | 54eA-01-09-20 controller with PID and TPC control and HART communications |

| CODE | SENSOR (optional selection) |
|---|---|
| 30 | 499ACL-02-54 sensor with standard cable |
| 31 | 499ACL-02-54-60 sensor with optimum EMI/RFI cable |
| 32 | 499ACL-02-54-VP sensor with Variopol 6.0 fitting (interconnecting cable must be ordered separately) |

## ACCESSORIES — SAMPLE CONDITIONING SYSTEM

| PN | Description | Weight* | Ship Weight** |
|---|---|---|---|
| 24134-00 | Air pump, 115 Vac, 50/60 Hz | 1 lb (0.5 kg) | 1 lb (0.5 kg) |
| 24134-01 | Air pump, 230 Vac, 50/60 Hz | 1 lb (0.5 kg) | 1 lb (0.5 kg) |
| 9160578 | Air pump repair kit | 1 lb (0.5 kg) | 1 lb (0.5 kg) |
| 9322052 | Check valve for air injection line | 1 lb (0.5 kg) | 1 lb (0.5 kg) |
| 24153-00 | Carboy for reagent, 5 gal/19 L, includes cap | 4 lb (1.5 kg) | 5 lb (2.0 kg) |
| 9100204 | Fuse, 0.25 A, 250 V, 3AG, slow blow for option -11 (115 Vac) | 1 lb (0.5 kg) | 1 lb (0.5 kg) |
| 9100132 | Fuse, 0.125 A, 250 V, 3AG, slow blow for option -12 (230 Vac) | 1 lb (0.5 kg) | 1 lb (0.5 kg) |
| 9380094 | Reagent pump, 115 Vac, 50/60 Hz | 1 lb (0.5 kg) | 2 lb (1 kg) |
| 9380095 | Reagent pump, 230 Vac, 50/60 Hz | 1 lb (0.5 kg) | 2 lb (1 kg) |
| 9380091 | Reagent pump replacement tubing | 1 lb (0.5 kg) | 2 lb (1 kg) |
| 24151-00 | Reagent tubing replacement kit | 1 lb (0.5 kg) | 2 lb (1 kg) |
| 24135-00 | Reagent uptake tubing, 6 ft (1.8 m), includes weight | 1 lb (0.5 kg) | 2 lb (1 kg) |
| 9380090 | Sample pump, 115 Vac, 50/60 Hz | 1 lb (0.5 kg) | 2 lb (1 kg) |
| 9380093 | Sample pump, 230 Vac, 50/60 Hz | 1 lb (0.5 kg) | 2 lb (1 kg) |
| 9380092 | Sample pump replacement tubing | 1 lb (0.5 kg) | 2 lb (1 kg) |
| 24152-00 | Sample tubing replacement kit | 1 lb (0.5 kg) | 2 lb (1 kg) |

| PN | Description | Weight* | Ship Weight** |
|---|---|---|---|
| 24165-00 | Acetic acid, 2 x 2.5 gal (9.5 L) bottles/case, with 25 g potassium iodide (0-5 ppm total chlorine) | 45 lb (20.5 kg) | 48 lb (22.0 kg) |
| 24165-01 | Acetic acid, 2 x 2.5 gal (9.5 L) bottles/case, with 50 g potassium iodide (0-10 ppm total chlorine) | 45 lb (20.5 kg) | 48 lb (22.0 kg) |
| 24164-00 | Potassium iodide, 25 g, sufficient for 5 gallons (19 L) of vinegar (0-5 ppm total chlorine) | 1 lb (0.5 kg) | 1 lb (0.5 kg) |
| 24164-01 | Potassium iodide, 50 g, sufficient for 5 gallons (19 L) of vinegar (0-10 ppm total chlorine) | 1 lb (0.5 kg) | 1 lb (0.5 kg) |

## ACCESSORIES — 54eA Analyzer

| PN | DESCRIPTION | WEIGHT* | SHIP WEIGHT* |
|---|---|---|---|
| 2002577 | Wall and two inch pipe mounting kit | 2 lb (1.0 kg) | 3 lb (1.5 kg) |
| 23545-00 | Panel mounting kit | 2 lb (1.0 kg) | 3 lb (1.5 kg) |
| 23554-00 | Cable glands, kit (Qty 5 of PG 13.5) | 1 lb (0.5 kg) | 1 lb (0.5 kg) |
| 9240048-00 | Stainless steel tag (specify marking) | 1 lb (0.5 kg) | 1 lb (0.5 kg) |

## ACCESSORIES — Sensor

| PN | DESCRIPTION | WEIGHT* | SHIP WEIGHT* |
|---|---|---|---|
| 23501-02 | Total Chlorine Membrane, includes one membrane assembly and one O-ring | 1 lb (0.5 kg) | 1 lb (0.5 kg) |
| 23502-02 | Total Chlorine Membrane Kit, includes 3 membrane assemblies and three O-rings | 1 lb (0.5 kg) | 1 lb (0.5 kg) |
| 9210438 | Total Chlorine Sensor Fill Solution, 4 oz (120 mL) | 1 lb (0.5 kg) | 2 lb (1.0 kg) |

## FOR FIRST TIME VARIOPOL INSTALLATIONS

| PN | DESCRIPTION | WEIGHT* | SHIP WEIGHT* |
|---|---|---|---|
| 23747-02 | VP 6.0 interconnecting cable, 10 ft (3 m) | 1 lb (0.5 kg) | 2 lb (1.0 kg) |
| 23747-03 | VP 6.0 interconnecting cable, 50 ft (15 m) | 5 lb (2.5 kg) | 6 lb (3.0 kg) |
| 23747-04 | VP 6.0 interconnecting cable, 4 ft (1.2 m) | 1 lb (0.5 kg) | 1 lb (0.5 kg) |

# SECTION 2. PRINCIPLES OF OPERATION

Total chlorine by definition is the iodine produced in a sample when it is treated with potassium iodide at a pH between 3.5 and 4.5. Typically, acetic acid (or vinegar) is used to adjust the pH.

The total chlorine analyzer consists of a sample conditioning system, which injects the reagent into the sample, and a sensor and analyzer, which measure the amount of iodine produced. Figure 2-1 shows the sample conditioning system. The sample enters the sample conditioning enclosure and flows to an overflow sampler from which the sample pump takes suction. Excess sample drains to waste. At the same time, the reagent pump draws reagent, a solution of potassium iodide in vinegar, from the reagent carboy and injects it into the suction side of the sample pump. The sample and reagent mix as they pass through the pump, and total chlorine in the sample is converted to the chemically equivalent amount of iodine. The flow rates are 11 mL/min for the sample and 0.2 mL/min for the reagent.

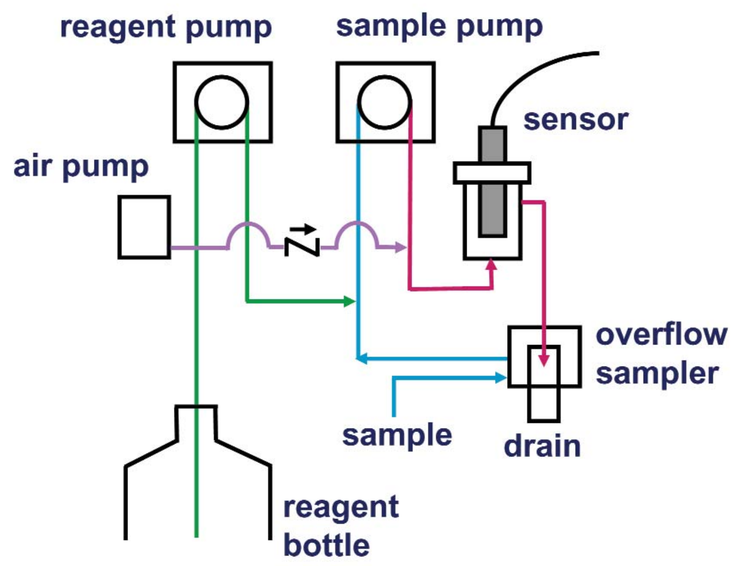



FIGURE 2-1. Schematic of Sample Conditioning System and Analyzer.

The treated sample next enters the flow cell. Bubbles injected into the flow cell produce turbulence, which improves the stability of the reading. A membrane-covered amperometric sensor in the flow cell measures the concentration of iodine. The analyzer receives the raw signal from the sensor and displays the concentration of total chlorine. Display units are ppm (mg/L) chlorine as $Cl_2$. The treated sample leaves the flow cell and drains to waste along with the excess sample.

# SECTION 3. INSTALLATION

## 3.1 UNPACKING AND INSPECTION

Inspect the shipping containers. If there is damage, contact the shipper immediately for instructions. Save the boxes. If there is no apparent damage, unpack the containers. Be sure all items shown on the packing list are present. If items are missing, notify Rosemount Analytical immediately.

## 3.2 INSTALLATION.

### 3.2.1 General Information

1. Although the analyzer and sample conditioning system are suitable for outdoor use, do not install them in direct sunlight or in areas of extreme temperature.

> **CAUTION**
> The TCL Total Chlorine analyzer is NOT suitable for use in hazardous areas.

2. Install the analyzer and sample conditioning system in an area where vibration and electromagnetic and radio frequency interference are minimized or absent.
3. Keep the analyzer and sensor wiring at least one foot from high voltage conductors. Be sure there is easy access to the analyzer and sample conditioning system.
4. The analyzer is suitable for panel, pipe or wall mounting. The sample conditioning enclosure must be mounted on a wall. Provide adequate room beneath the enclosure for the 5-gallon reagent carboy.
5. Be sure that the distance between the analyzer and sample conditioning cabinet does not exceed the length of the sensor cable.

### 3.2.2 Install the Analyzer

1. Refer to the appropriate figure for installation details.

| Type of Mounting | Figure(s) |
|---|---|
| Wall | 3-1 |
| Pipe | 3-2 and 3-3 |
| Panel | 3-4 and 3-5 |

2. See Section 4.3 for wiring instructions.

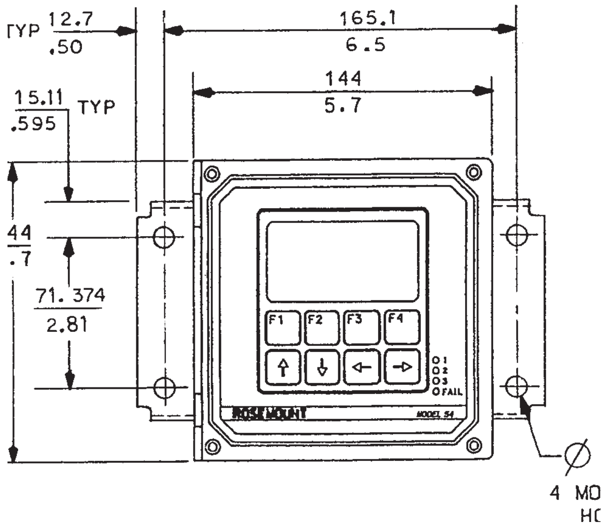



FIGURE 3-1. Wall Mounting

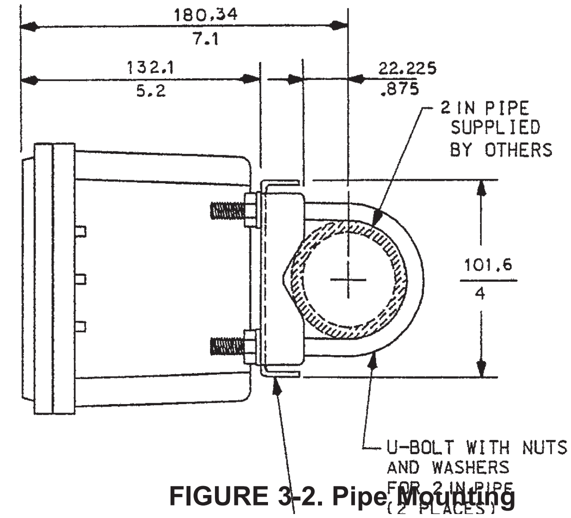
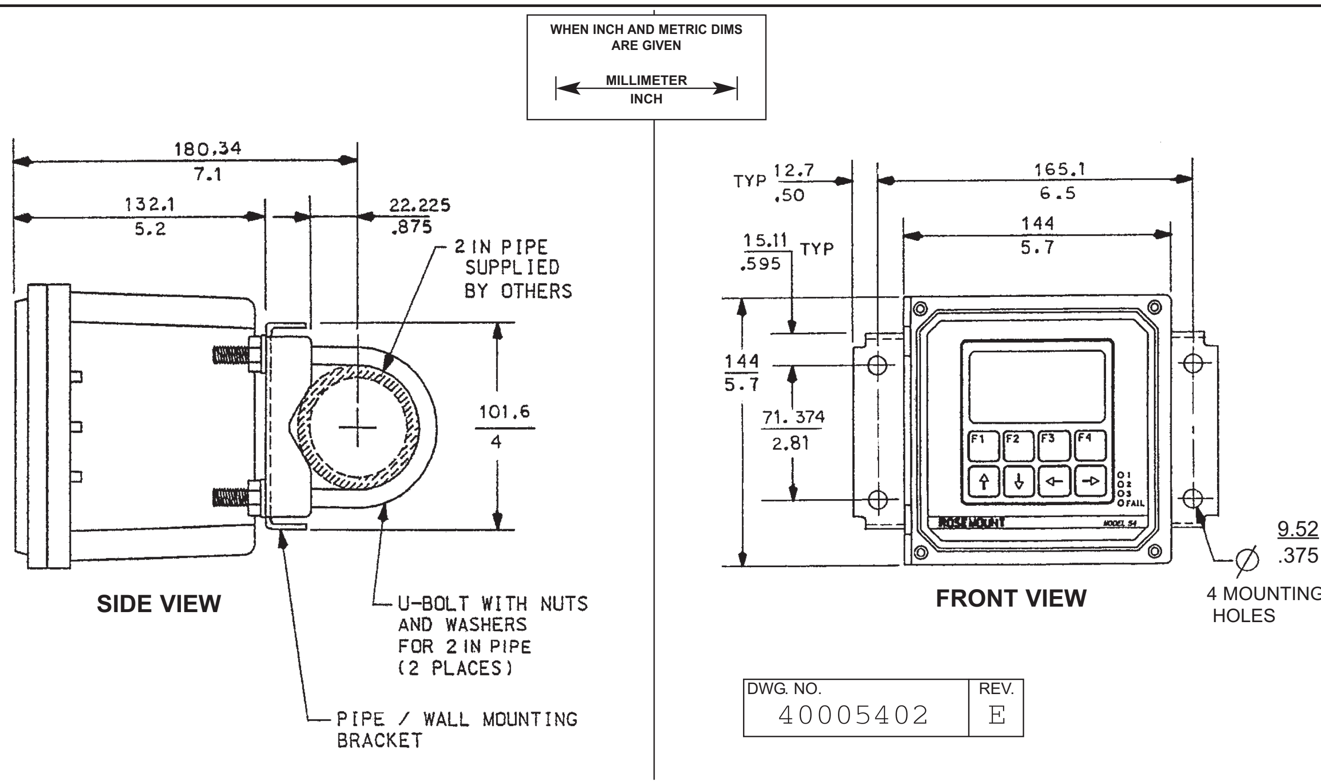



FIGURE 3-2. Pipe Mounting




**PIPE MOUNTING** **PN 2002577** **WALL MOUNTING**

**FIGURE 3-3. Pipe and Wall Mounting Dimensions**

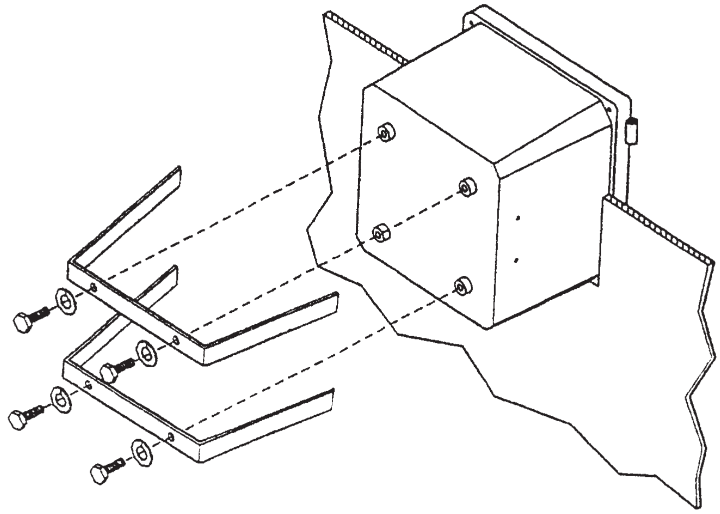


FIGURE 3-4. Panel Mounting

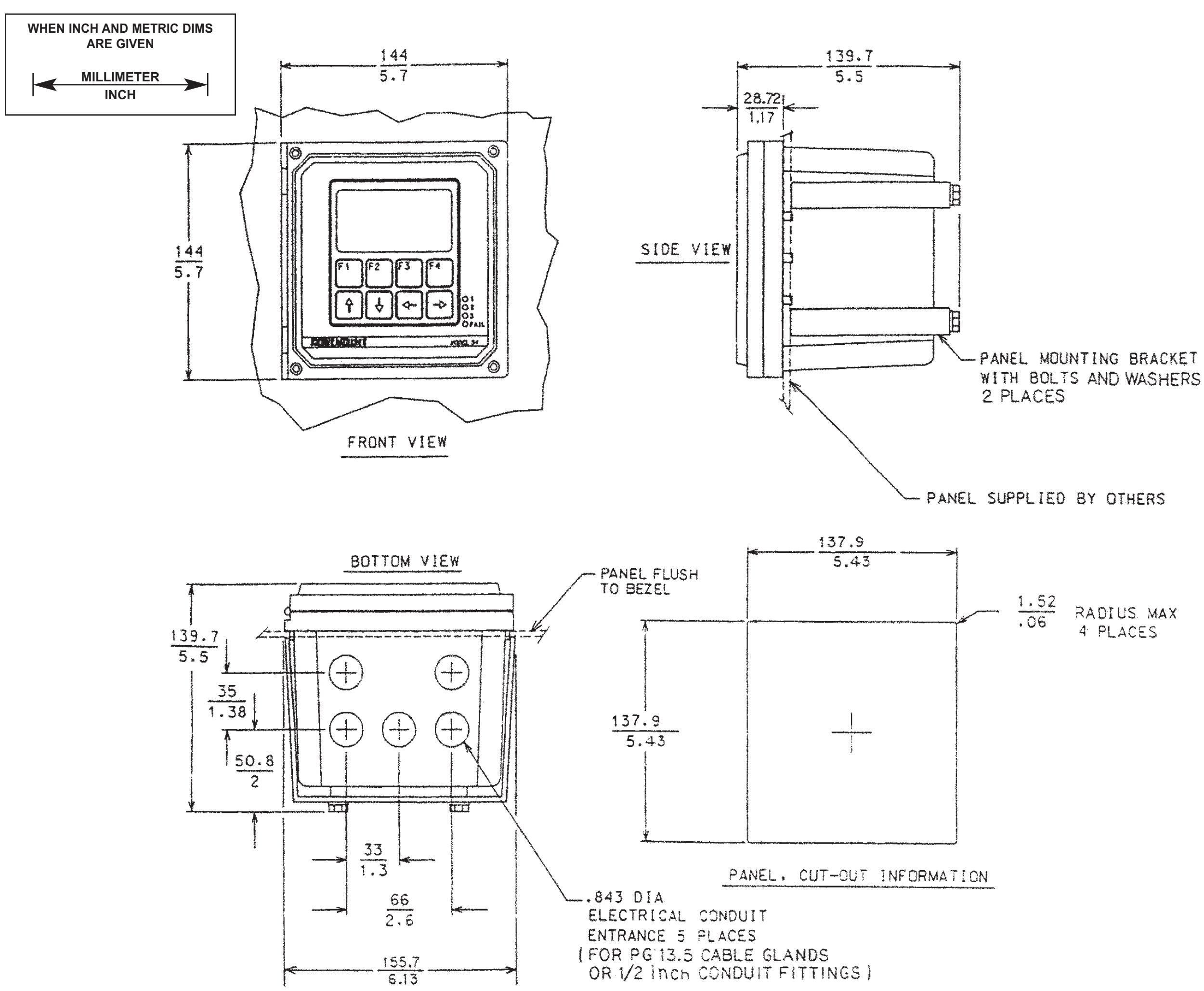



FIGURE 3-5. Panel Mounting Dimensions

### 3.2.3 Install the Sample Conditioning Enclosure

1. Refer to Figures 3-6 and 3-7 for installation details.
2. Connect the sample line to the sample conditioning system. Use ¼-inch OD hard plastic or stainless steel tubing. If dechlorinated water is being measured, provide a way of substituting a chlorinated water sample for the dechlorinated sample. Chlorinated water is needed to calibrate the sensor and to check its response.
3. If a grab sample tap is not already available, install one in the process piping. Choose a point as close as possible to the sample line supplying the TCL. Be sure that opening the sample valve does not appreciably alter the flow of sample to the instrument.
4. Connect the drain to a length of ¾-inch ID flexible plastic tubing. The sample **must** drain to open atmosphere.
5. Find the reagent tubing and fitting in the plastic bag taped to the inside of the enclosure door. Screw the reagent fitting onto the bulkhead fitting at the bottom left of the enclosure. Pass the reagent tubing through the hole in the carboy cap. Be sure the plastic weight will be inside the carboy when the cap is placed on the carboy. Attach the reagent tubing to the barbed connector. See Figure 3-8.
6. Place the blue plastic carboy beneath the enclosure. Place the weighted end of the reagent tubing inside the carboy. To prepare reagent, see Section 5.2.

### 3.2.4 Install the Sensor

1. From inside the sample conditioning enclosure, thread the sensor cable through the gland on the upper left side. Leave about one foot of cable inside the enclosure.
2. Wire the sensor to the analyzer. Refer to Section 4.3.
3. Remove the nut and adapter from the flow cell. Slip the nut over the end of the sensor. Thread the adapter onto the sensor. Hand tighten only. Remove the protective cap from the end of the sensor.
4. Insert the sensor in the flow cell. Hand tighten the nut.

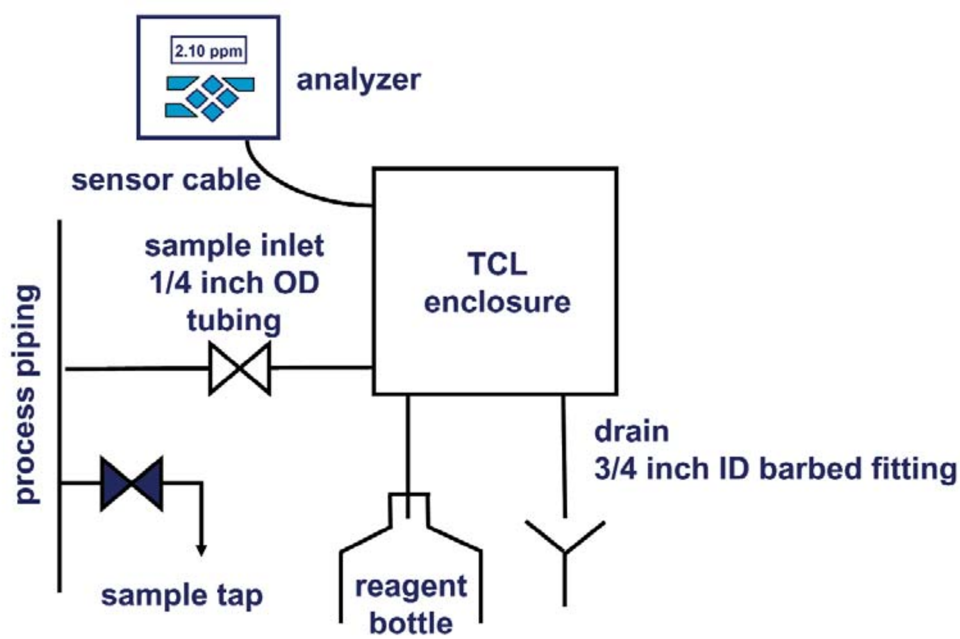



**FIGURE 3-6. Installing the Sample Conditioning Enclosure**

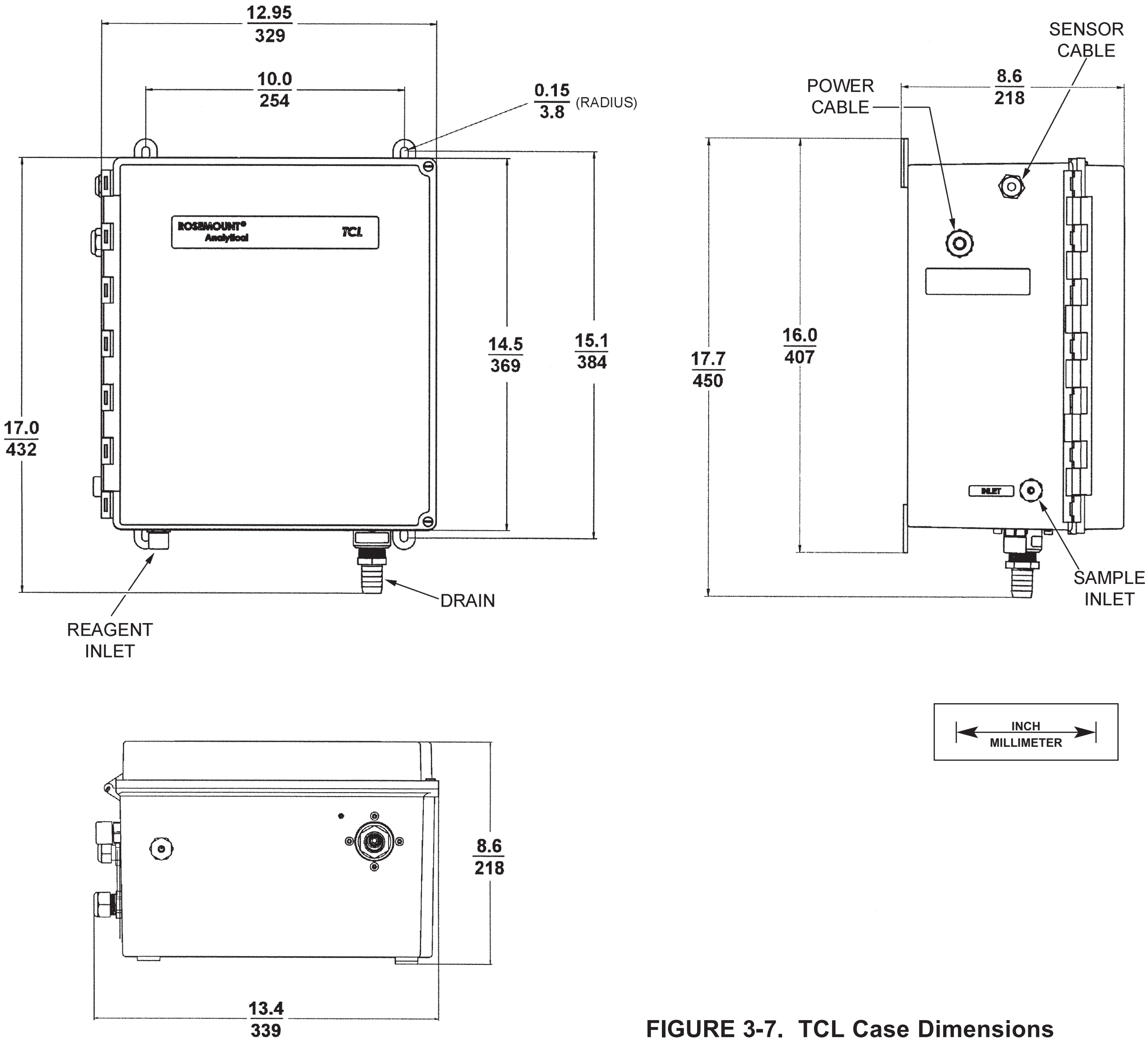



**FIGURE 3-7. TCL Case Dimensions**

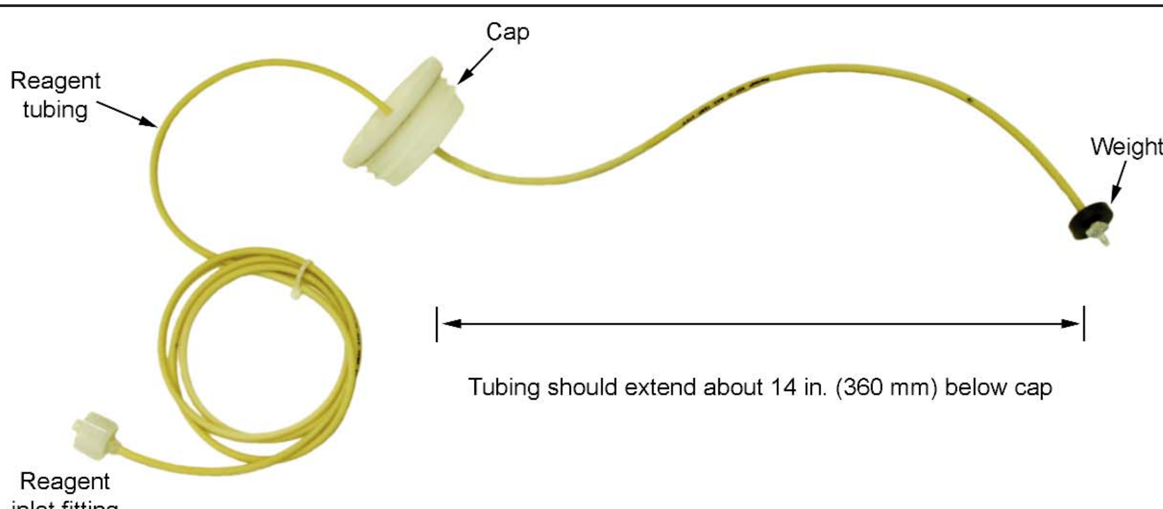



**FIGURE 3-8. Attaching reagent tubing**

# SECTION 4. WIRING

**NOTE**

**The Model 54eA analyzer leaves the factory configured for use with the Model 499ADO oxygen sensor. Because a 499ADO sensor is NOT used in the TCL system, turn to Section 7.5 and configure the analyzer to read total chlorine before wiring the sensor to the analyzer. Operating the analyzer and sensor for longer than five minutes while the analyzer is improperly configured will greatly increase the stabilization time for the sensor.**

**Be sure to turn off power to the analyzer before wiring the sensor.**

## 4.1 GENERAL

**WARNING**

Electrical installation must conform to the National Electrical Code, all state and local codes, and all plant codes and standards for electrical equipment. Electrical installation and wiring must be done by qualified personnel.

The five holes in the bottom of the instrument case accept 1/2-in. strain relief connectors or conduit fittings. The rear openings are for power and alarm relay wiring. The left front opening is for sensor wiring and the right front opening is for analog output wiring. Seal unused openings with conduit plugs.

## 4.2 PROVIDE POWER TO THE SAMPLE CONDITIONING SYSTEM

**WARNING: RISK OF ELECTRICAL SHOCK**
AC connections and grounding must be in compliance with UL 508 or local electrical code. DO NOT apply power to the analyzer until all electrical connections are verified and secure.

**NOTE**

Provide a switch or breaker to disconnect the sample conditioning cabinet from the main power supply. Install the switch or breaker near the unit and identify if as the disconnecting device for the sample conditioning system.

1. Be sure the pump switches on the wiring access panel are in the off position.
2. Remove the four screws securing the wiring access panel. Pull the panel out of the way to reveal the power terminal strip.
3. Insert the power cable through the strain relief connection labeled power (see Figure 3-7). Wire the power cable to the terminal strip as shown in Figure 4-1. Do not apply 230 Vac power to a 115 Vac TCL (Model option -11). Doing so will damage the instrument.
4. **Leave the pump power switches off until ready to start up the unit.** See Section 5.

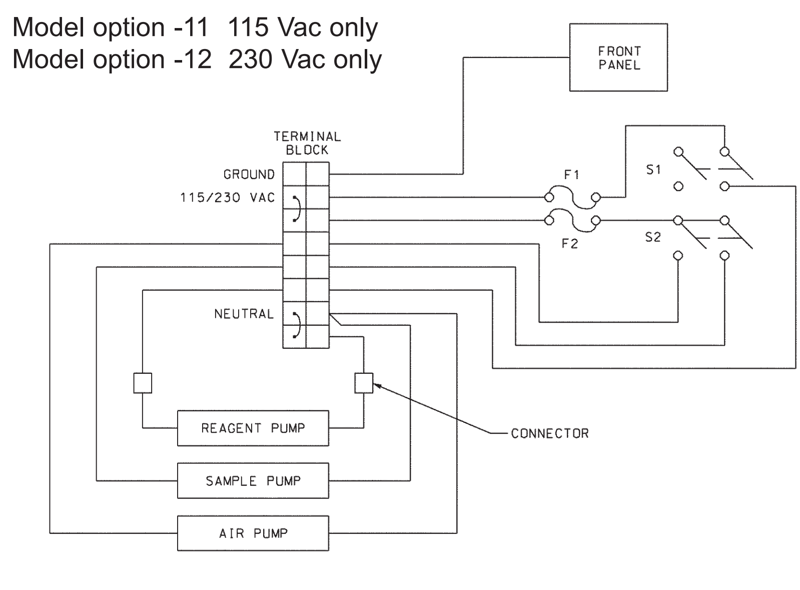



**FIGURE 4-1. Power Wiring**

## 4.3 MAKE POWER, ALARM, OUTPUT AND SENSOR CONNECTIONS IN THE ANALYZER

Refer to Figure 4-2. Make power and alarm connections on TB3. Make analog output wiring connections on TB2. For access to power and alarm terminals, loosen the screw holding the protective cover in place and remove the cover.

**DANGER**

Live voltages may be present.
Will cause severe injury or death.

Alarm contacts are dry (i.e., not powered) and are normally open. Refer to Section 1.0 for relay specifications.

For best EMI/RFI protection, shield the output cable and enclose it in an earth-grounded, rigid, metal conduit. Connect the outer shield of the output cable to the earth ground connection on TB2 (see Figure 4-2).

Keep sensor and output signal wiring separate from power wiring. Do no run sensor and power cables in the same conduit or close together in a cable tray.

AC wiring must be 14 gauge or greater. Be sure to connect earth ground from the power cable to the nearby ground lug. A good earth ground is necessary for proper operation of the controller. Provide a switch or breaker to disconnect the analyzer from the main power supply. Install the switch or breaker near the analyzer and label it as the disconnecting device.

**WARNING: RISK OF ELECTRICAL SHOCK**

AC connections and grounding must comply with UL 508 or local electrical code. DO NOT apply power to the analyzer until all electrical connections are verified and secure.

**NOTE**

**The Model 54eA analyzer leaves the factory configured for use with the Model 499ADO oxygen sensor. Because a 499ADO sensor is NOT used in the TCL system, turn to Section 7.5 and configure the analyzer to read total chlorine before wiring the sensor to the analyzer. Operating the analyzer and sensor for longer than five minutes while the analyzer is improperly configured will greatly increase the stabilization time for the sensor.**

**Be sure to turn off power to the analyzer before wiring the sensor.**

The wiring label, which is shown in Figure 4-3, is a general purpose label. It has wiring information concerning other sensors, for example, contacting and inductive conductivity sensors, that can be used with the 54e instrument platform. For total chlorine measurements, only TB3 is used.

Refer to Figures 4-4 and 4-5 for sensor wiring. Use the pigtail wire and wire nuts provided with the sensor when more than one wire must be attached to a single terminal

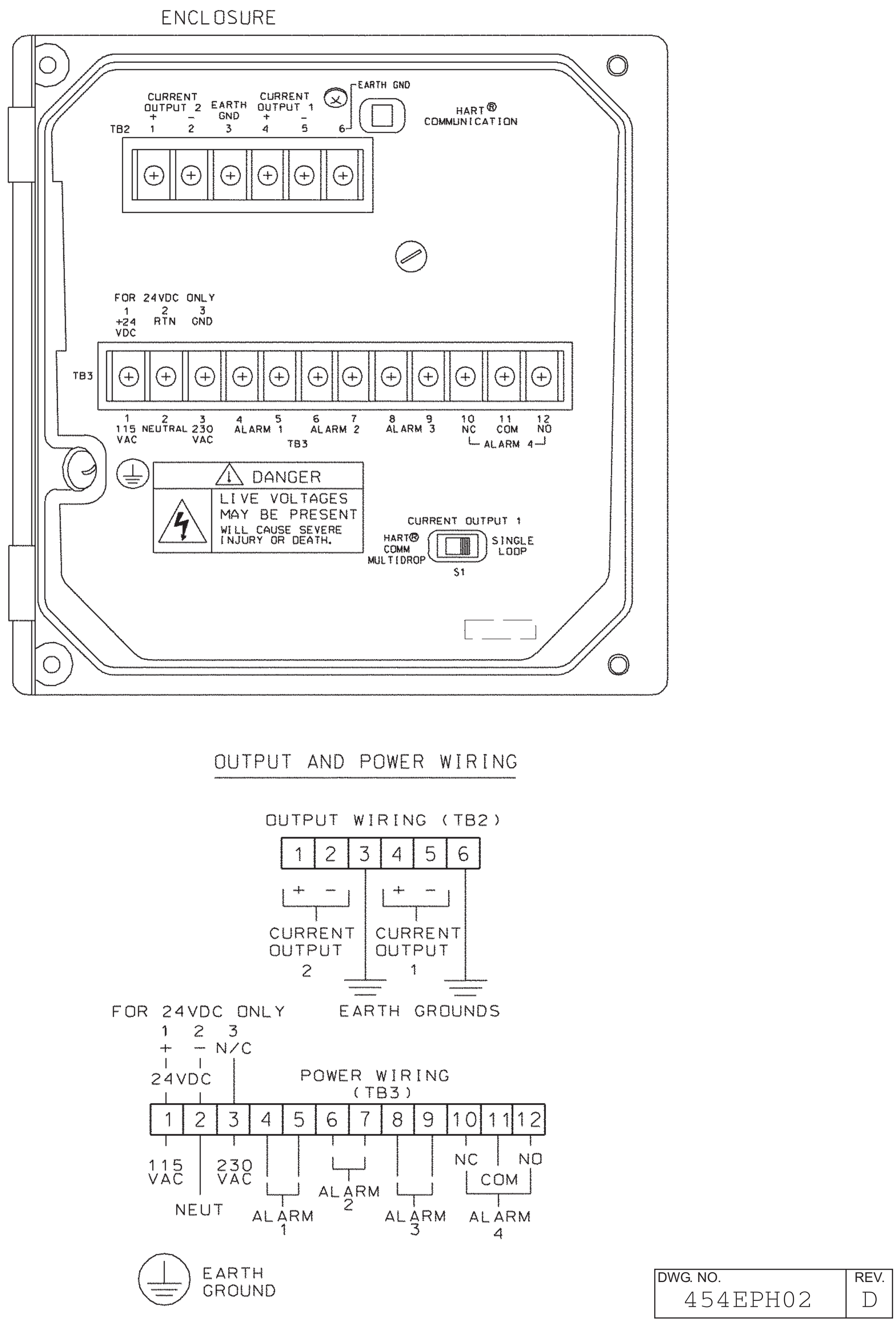



**FIGURE 4-2. Power Input and Relay Output Wiring for Model 54eA**

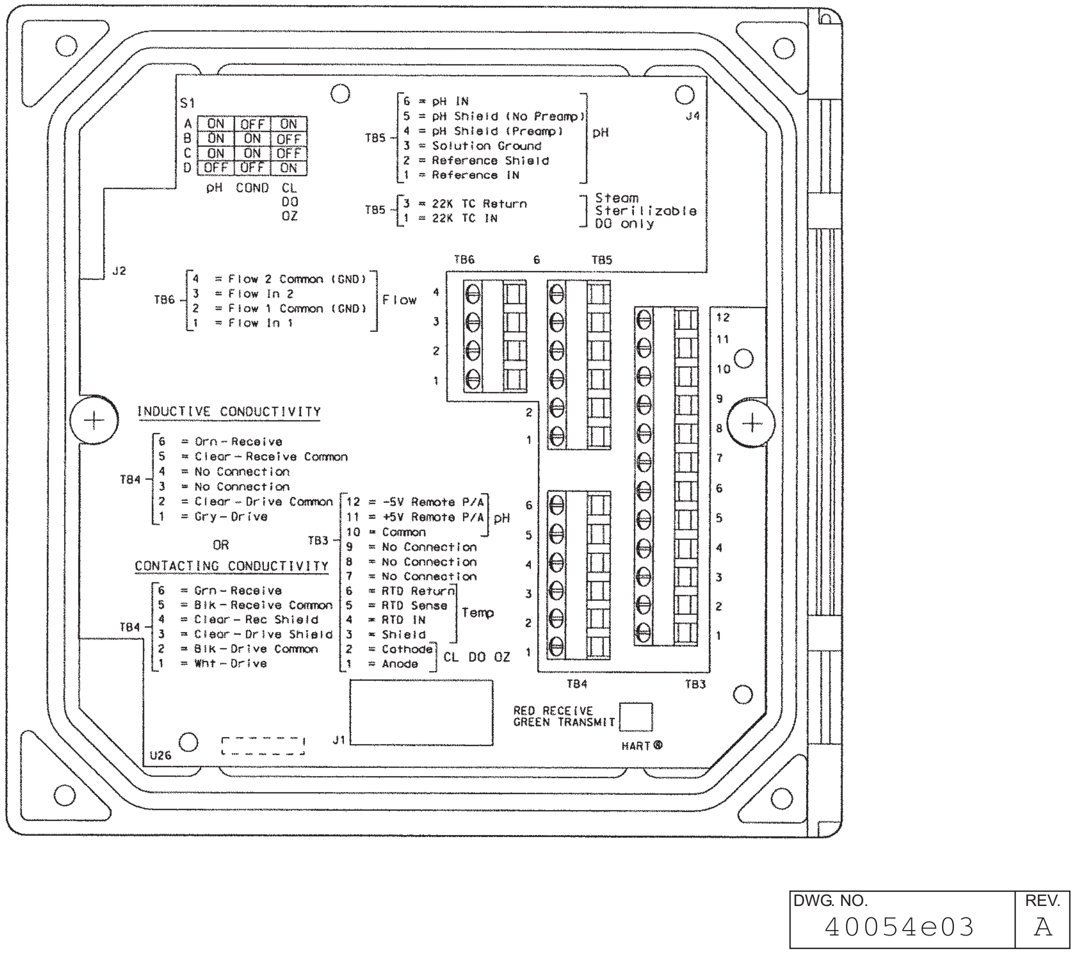



**FIGURE 4-3. Wiring Label**

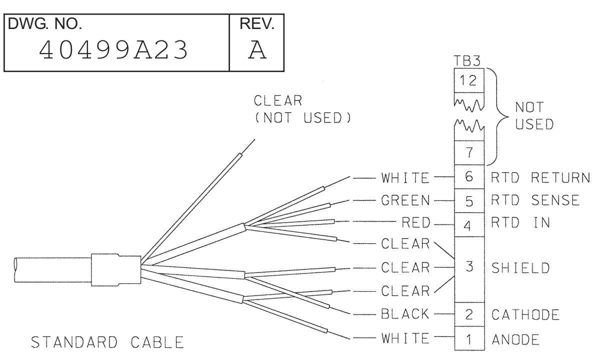



**FIGURE 4-4. Total chlorine sensor (499ACL-02) with standard cable.**

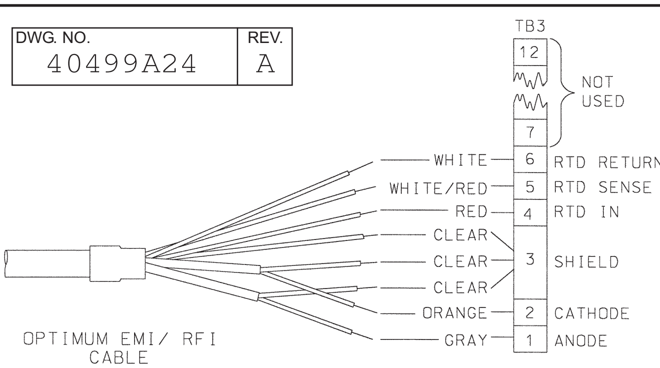



**FIGURE 4-5. Total chlorine sensor (499ACL-02) with optimum EMI/RFI cable or Variopol cable.**

# SECTION 5. START-UP

**NOTE**
Complete Section 4 before starting this section.

## 5.1 PREPARE THE REAGENT

**WARNING**
The reagent contains potassium iodide dissolved in distilled vinegar or 5% acetic acid. Avoid contact with skin and eyes. Wash thoroughly after using.

1. **DO NOT PREPARE THE SOLUTION UNTIL READY TO USE.**
2. Position the blue plastic carboy under the sample conditioning cabinet. Unscrew the cap and reagent tube assembly.
3. Add the potassium iodide reagent to the carboy. See the table.

| Expected range, ppm as Cl2 | Amount of KI needed per 5 gal (19 L) of vinegar | Part number |
|---|---|---|
| 0 – 5 ppm | 25 grams | 24164-00 |
| 0 – 10 ppm | 50 grams | 24164-01 |
| 0 – 20 ppm | 2 x 50 grams | 24164-01 |

4. Add five gallons (19 L) of distilled white vinegar one gallon (4 L) at a time. Swirl the carboy after each addition
5. Screw the cap on the carboy. Be sure the reagent uptake tube extends to the bottom of the carboy.
6. Connect the reagent tube to the small fitting on the bottom left hand side of the enclosure.

**NOTE**
The shelf life of the potassium iodide vinegar solution is at least two months if stored in the blue carboy. Do not store the reagent in a container other than the blue carboy. The reagent is sensitive to sunlight, which the blue carboy effectively blocks.

## 5.2 ZERO THE SENSOR

1. Place the sensor in a beaker of deionized water or simply place the sensor in air.
2. Let the sensor operate until the sensor current is stable, then zero the sensor. See Section 8.3.2 for detailed instructions.

## 5.3 START SAMPLE FLOW

Adjust the sample flow until a slow stream of liquid is running down the inside tube of the sampling cup.

## 5.4 BEGIN OPERATION AND CALIBRATE THE SENSOR

1. Turn on the reagent and sample pump switches. Observe that liquid begins to fill the flow cell. The sample flow is about 11 mL/min, so the flow cell will fill rather slowly. Also observe that the air pump is operating. The pump will produce very vigorous bubbling in the flow cell.
2. Once the flow of reagent starts, it takes about two minutes for the reagent to reach the flow cell. If the concentration of total chlorine in the sample is greater than about 0.5 ppm, the treated sample in the flow cell will be pale yellow. Sample containing more chlorine will be dark yellow.
3. Monitor the sensor current. Once the reading is stable, calibrate the unit. See Section 9.3.3 for detailed instructions. It may take thirty minutes or longer for the reading to stabilize when the sensor is first put in service.

# SECTION 6. DISPLAY AND OPERATION

## 6.1 GENERAL DESCRIPTION

The 54eA analyzer/controller is a single input, dual output instrument. Figure 6-1 shows how the instrument inputs and outputs can be configured for total chlorine.

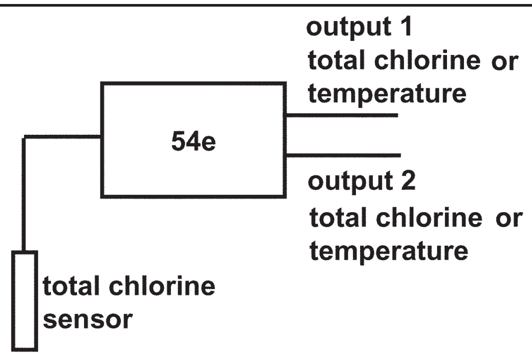



**FIGURE 6-1. Configuration of Outputs for Total Chlorine**

*Outputs can be assigned to total chlorine or to temperature. The outputs can be configured as either linear (4-20 mA) or PID outputs.*

In addition to PID control, the 54eA controller can be used for time proportional control (TPC). TPC control uses the alarm relays.

## 6.2 DISPLAY

Figure 6-2 shows the main display.

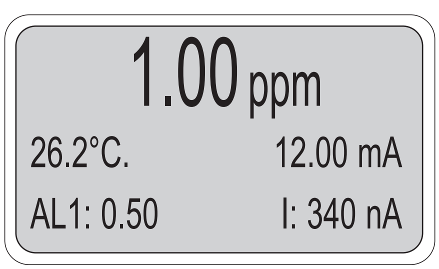



**FIGURE 6-2. Main Display Screen**

*The total chlorine measurement is always displayed continuously in large numerals. The temperature and output current are always displayed on the second line of the main display. The third line can be configured by the user. In the example, the third line shows the alarm 1 setpoint and the total chlorine sensor current in nA.*

## 6.3 KEY FUNCTIONS AND CONTROLS

The keys labeled F1, F2, F3, and F4 are multi-function. The function appears in the main display just above the key. For example, F1 is usually labeled Exit and F4 may be labeled Edit, Save, or Enter.

1. To enter the main menu, press any key.
2. Use the ↑ and ↓ keys to move the cursor to the desired sub-menu. The position of the cursor is shown in reverse video.

   **NOTE**

   **When the last item of a menu has been reached, the cursor will be on the third line of the display. If the cursor is on the second line of the display more items remain. Continue pressing the ↓ key.**
3. Press Enter (F4) to access a sub-menu or an item in a sub-menu.
4. To change a number or a setting press Edit (F4). The display will change to show the cursor on the first digit or on a + or - sign. Use the ↑ and ↓ keys to increase or decrease a digit or to toggle the + and - signs. Use the ← and → keys to move the cursor left and right.
5. If an entire number or a word is highlighted, use the ↑ and ↓ keys to scroll through the list of choices.
6. To store a number or setting in memory, press Save (F4).
7. To leave without storing changes, press Esc (F3).
8. To leave and return to the previous screen, press Exit (F1).
9. To end a calibration step and leave the previous calibration in place, press Abort (F1).
10. Occasionally, information screens will appear. To leave the information screen and move to the next screen press Cont (F3).

## 6.4 ALARM STATUS

Green LEDs (labeled 1, 2, and 3) indicate when alarm relays 1, 2, and 3 are energized. The fourth relay indicates a fault condition. When a fault occurs, the red LED (labeled FAIL) lights up, a descriptive error message appears, and the outputs and alarm relays act as described in Section 7.6 and Section 7.7 under fault value.

The red LED also indicates when the interval timer routine is activated and when the time limit has been reached on a feed limit timer. For more information on these subjects, see Section 7.7.



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# SECTION 7.  SOFTWARE CONFIGURATION

**The instrument is configured at the factory to measure oxygen. To change the measurement to total chlorine, see Section 7.5.**

Figure 7-1 is an outline of the menu structure.

Table 7-1 lists the default settings and the range of choices available for each setting. Only settings related to total chlorine are shown. To reduce the chance of error when configuring the controller the first time, enter settings in the order shown in the table.

**TABLE 7-1. Program Settings List**

| ITEM | CHOICES | FACTORY SETTINGS |
|---|---|---|
| **SETPOINTS** | | |
| **A. Alarms (Section 7.1)** | | |
| 1. Alarm 1 (low action) | | |
| a. if chlorine | -9999 to 9999 ppm | 0 ppm |
| b. if temperature | -5 to 130°C | 0.1°C |
| 2. Alarm 2 (high action) | | |
| a. if chlorine | -9999 to 9999 ppm | 20 ppm |
| b. if temperature | -5 to 130°C | 130°C |
| 3. Alarm 3 | See alarm 2 | See alarm 2 |
| **B. Outputs (Section 7.2 and 7.3)** | | |
| 1. Output 1 or 2: 4 mA setting | | |
| a. if chlorine | -9999 to 9999 ppm | 0 ppm |
| b. if temperature | -5 to 130°C | 0.1°C |
| 2. Output 1 or 2: 20 mA setting | | |
| a. if chlorine | -9999 to 9999 ppm | 20 ppm |
| b. if temperature | -5 to 130°C | 130°C |
| 3. Setpoint (PID) | | |
| a. if chlorine | -9999 to 9999 ppm | 1.00 ppm |
| b if temperature | -5 to 130°C | 25°C |
| **A. Display options (Section 7.5)** | | |
| 1. Measurement | Oxygen, ozone, free chlorine, total chlorine, monochloramine | Oxygen |
| 2. Temperature units | °C or °F | °C |
| 3. Output 1 | mA or % of full scale | mA |
| 4. Output 2 | mA or % of full scale | mA |
| 5. Language | English, Français, Español, Deutsch, Italiano | English |
| 6. Main display left | See section 6.5 | Sensor current |
| 7. Main display right | See section 6.5 | Output 1 current |
| 8 Display contrast | 00-99 (darkest) | 50 |
| 9. Test timeout | On or off | On |
| 10. Timeout value | 1 to 60 min | 10 min |

*Continued on the following page*

**TABLE 7-1. Program Settings List** ***(continued)***

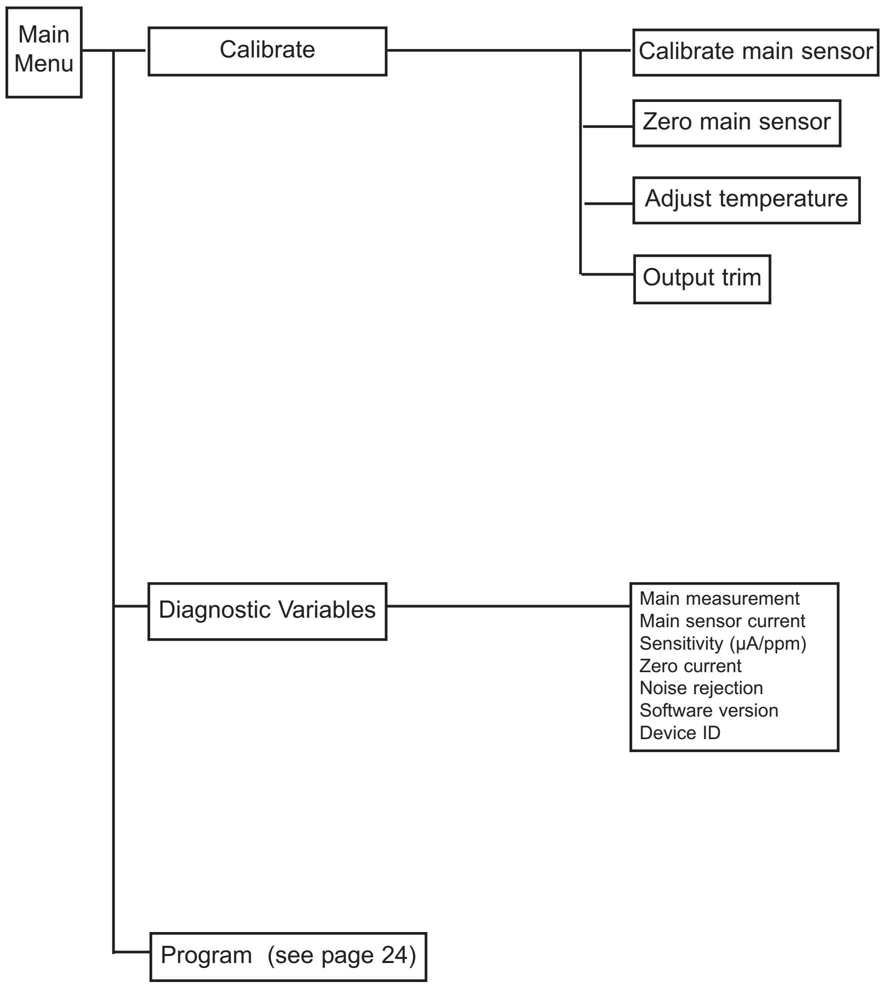
| ITEM<br>CONFIGURE | CHOICES | FACTORY SETTINGS |
|---|---|---|
| **B Outputs (Section 7.6)** | | |
| 1. Output 1 Control | | |
| a. Measurement | Oxygen, chlorine, ozone, pH, or temperature | Oxygen |
| b. Control | Normal or PID | Normal |
| 2. Output 1 Setup (normal) | | |
| a. Current | 4-20 mA or 0-20 mA | 4-20 mA |
| b. Dampening | 0-299 sec | 0 sec |
| c. Hold mode | Hold last value or go to fixed value | Hold last value |
| d. Fixed hold value | 0-22 mA | 21 mA |
| e. Fault value | 0-22 mA | 22 mA |
| 3. Output 1 Setup (PID) | | |
| a. Proportional | 0 to 299.9% | 100 % |
| b. Integral | 0 to 2999 sec | 0 sec |
| c. Derivative | 0 to 299.9% | 0/0% |
| 4. Output 2 Control | | |
| a. Measurement | Oxygen, chlorine, ozone, pH, or temperature | Temperature |
| b. Control | Normal or PID | Normal |
| 5. Output 2 Setup (normal) | See output 1 | See output 1 |
| 6. Output 2 Setup (PID) | See output 1 | See output 1 |
| 7. Hold feature | Enable, disable, or 20 min timeout | Disable |
| | | |
| **C. Alarms (Section 7.7)** | | |
| 1. Alarm 1 Control | | |
| a. Activation method | Chlorine or temperature | Chlorine |
| b. Control mode | Normal or TPC | Normal |
| 2. Alarm 1 setup (normal) | | |
| a. Configuration | Low, high, or off | High |
| b. Hysteresis | | |
| if chlorine | -9999 to 9999 ppm | 0 ppm |
| if temperature | 0 to 10°C | 0.1°C |
| c. Delay time | 0-99 sec | 0 sec |
| d. Relay fault | none, open, closed | None |
| 3. Alarm 1 setup (TPC) | | |
| a. Setpoint | | |
| if chlorine | -9999 to 9999 ppm | 1.0 ppm |
| if temperature | -5 to 130°C | 25°C |
| b. Proportional | 0 to 299.9% | 100 % |
| c. Integral | 0 to 2999 sec | 0 sec |
| d. Derivative | 0 to 299.9% | 0.0% |
| e. Time period | 10 to 2999 sec | 30 sec |
| f. LRV (100% on) | | |
| if chlorine | -9999 to 9999 ppm | 0 ppm |
| if temperature | -5 to 130°C | 0°C |
| g. URV (100% off) | | |
| if chlorine | -9999 to 9999 ppm | 2 ppm |
| if temperature | -5 to 130°C | 100°C |
| h. Relay fault | None, open, or closed | None |


*Continued on the following page*

## TABLE 7-1. Program Settings List *(continued)*

| ITEM | CHOICES | FACTORY SETTINGS |
|---|---|---|
| **CONFIGURE (continued)** | | |
| **C. Alarms (Section 7.7)** ***(continued)*** | | |
| 4. Alarm 2 Control | | |
| a. Activation method | Chlorine, temperature | Chlorine |
| b. Control mode | Normal or TPC | Normal |
| 5. Alarm 2 setup (normal) | | |
| a. Configuration | Low, high, or off | Low |
| Rest of alarm 2 setup is the same as alarm 1 | | |
| 6. Alarm 3 control and setup is the same as alarm 1 | | |
| 7. Alarm 4 control | | |
| Alarm | Fault or off | Fault |
| 8. Feed limit timer | | |
| a. Feed limit | Disable, alarm 1, alarm 2, or alarm 3 | Disable |
| b. Timeout value | 0 to 10,800 sec | 600 sec |
| 9. Interval timer | | |
| a. Select alarm | Disable, alarm 1, alarm 2, or alarm 3 | Disable |
| b. Interval time | 0 to 999.9 hr | 24.0 hr |
| c. Repeats | 1 to 60 | 1 |
| d. On time | 0 to 2999 sec | 120 sec |
| e. Off time | 0 to 2999 sec | 1 sec |
| f. Recovery time | 0 to 999 sec | 600 sec |
| **D. Temperature compensation (Section 7.9)** | | |
| 1. Temperature compensation | Auto or manual | Auto |
| 2. Manual temperature | -15 to 130°C | 25°C |
| **E. Noise Reduction (section 7.10)** | | |
| Noise rejection | 50 or 60 Hz | 60 Hz |
| **F. Main sensor calibration (Section 7.11)** | | |
| 1. Stabilize reading | 0 to 9999 ppm | 0.05 ppm |
| 2. Stabilize time | 0 - 30 sec | 10 sec |
| 3. Sensor zero stabilization value | | |
| 4. Dual range calibration | Enable or disable | disable |
| **G. Security (Section 7.13)** | | |
| 1. Lock all | 000-999 (000 disables) | 000 |
| 2. Lock program | 000-999 (000 disables) | 000 |
| 3. Lock configuration | 000-999 (000 disables) | 000 |

**FIGURE 7-1. Menu Tree for the 54eA Controller**



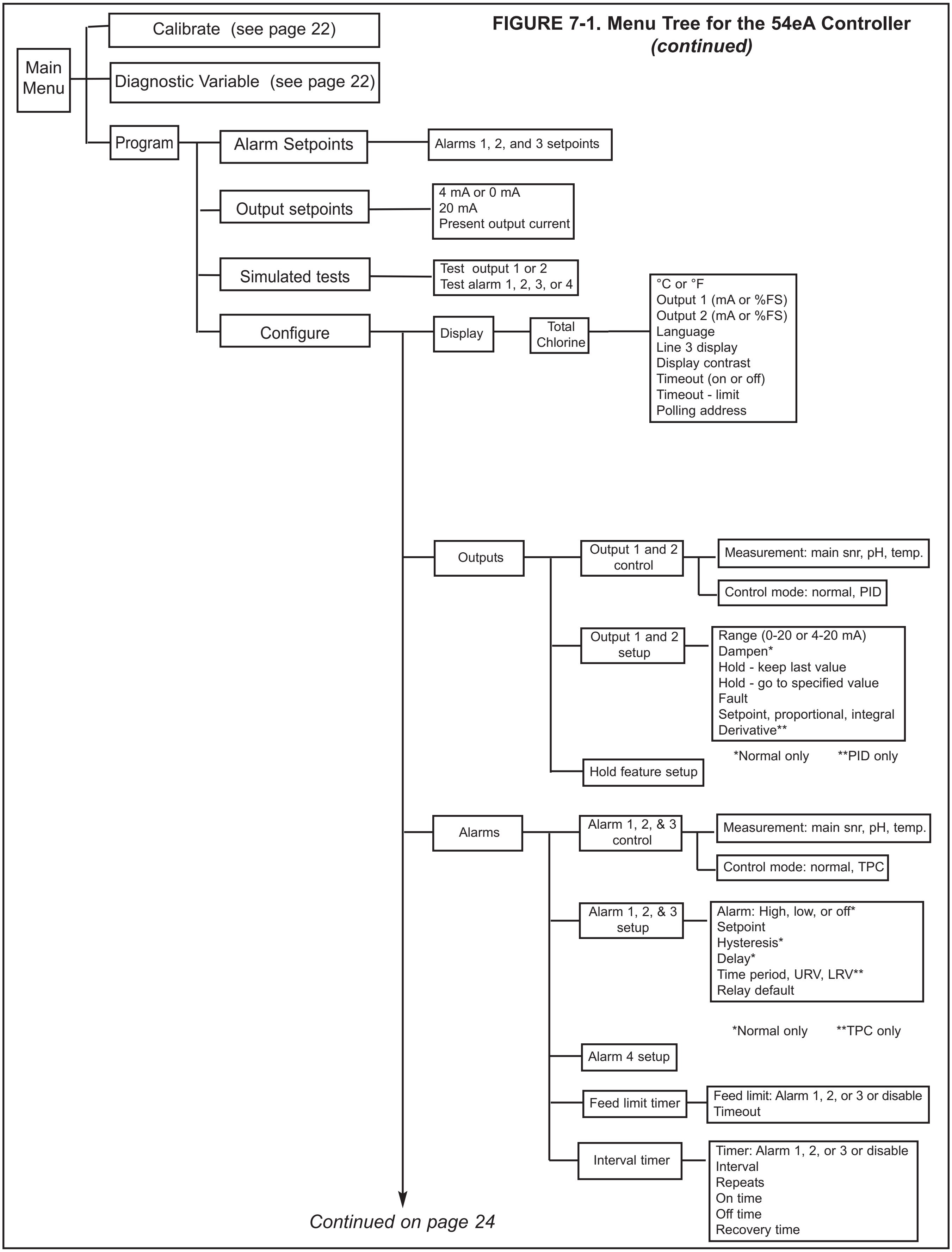
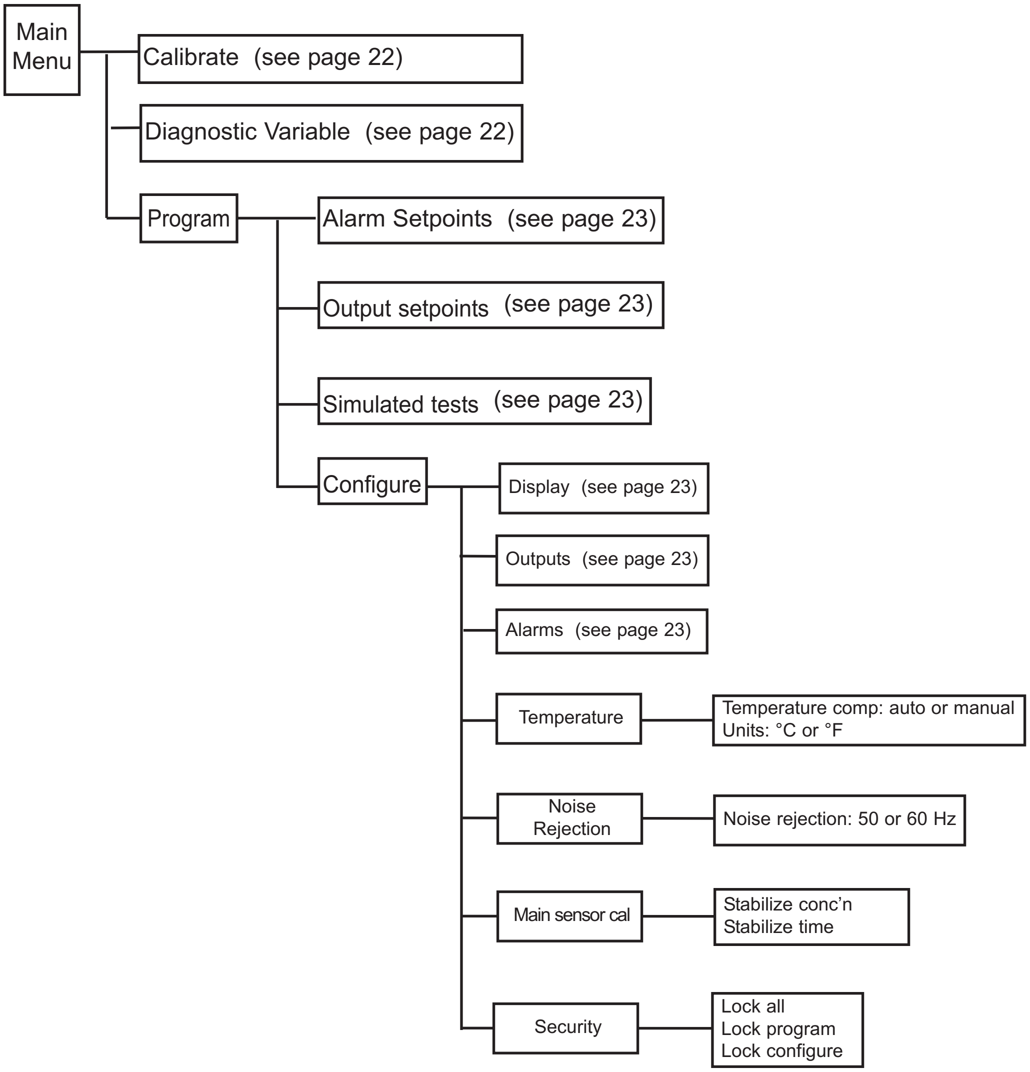



**FIGURE 7-1. Menu Tree for the 54eA Controller *(continued)***

*Continued on page 24*

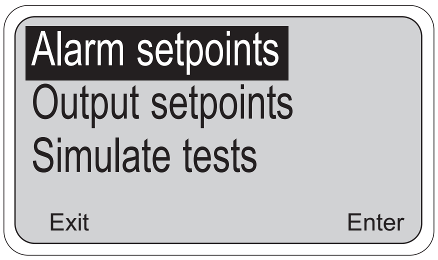
**FIGURE 7-1. Menu Tree for the 54eA Controller *(continued)***



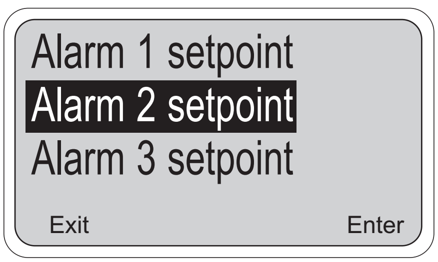
# 7.1 CHANGING ALARM SETPOINTS

1. **Before changing alarm setpoints, be sure that alarms are properly configured. See Section 7.7.**

2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).

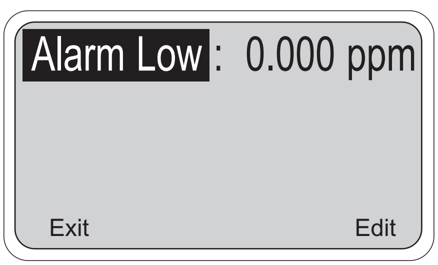



3. Press Enter (F4).

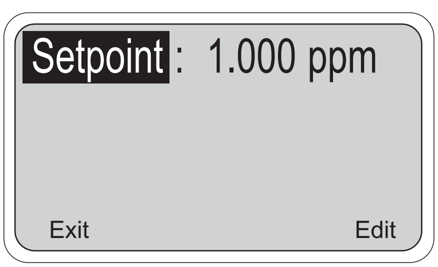



4. Move the cursor to the desired alarm and press Enter (F4).

5. The screen appearing at this point depends on how the alarm was configured.




6. If the alarm is a normal (i.e., not TPC) alarm, a screen like the one shown will appear. The alarm is a low alarm and the setpoint is 0.00 ppm. Press Edit (F4). Use the arrow keys to change the setpoint. Press Save (F4) to store the new value. Press Exit (F1) to return to the screen in step 4. Choose a new alarm.

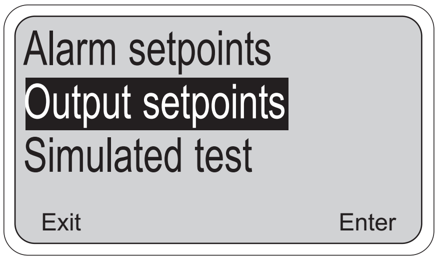



7. If the alarm is TPC, a screen like the one shown will appear. The setpoint is +1.000 ppm. Press Edit (F4). Use the arrow keys to change the setpoint. Press Save (F4) to store the new value. Press Exit (F1) to return to the screen in step 4. Choose a new alarm.

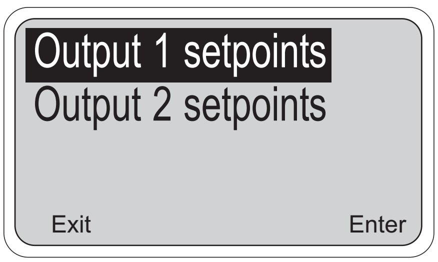
## 7.2 RANGING THE OUTPUTS

1. Ranging the outputs means assigning values to the low (0 or 4 mA) and high (20 mA) outputs. **Before ranging the outputs, be sure the outputs are properly configured. See Section 7.6.**

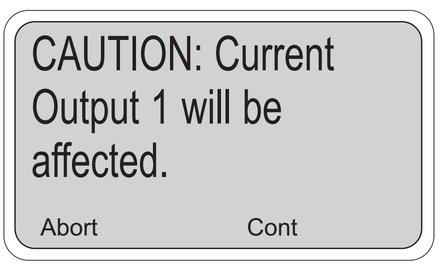
2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).



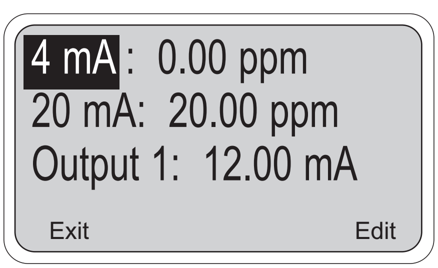

3. Move the cursor to "Output setpoints" and press Enter (F4).




4. Move the cursor to the desired output and press Enter (F4).




5. This screen confirms that changes to output 1 are going to be made. Use caution. Changes may degrade process control. Press Cont (F3) to continue. Otherwise, press Abort (F1).




6. This screen shows the present settings for Output 1. If the output was configured to be 0-20 mA, the first line will show "0mA" instead of "4mA". The live current output is shown on the third line.

   Move the cursor to the desired line and press Edit (F4). Use the arrow keys to change the setpoint. Press Save (F4) to store the new value.

   Press Exit (F1) to return to the screen in step 4. Choose the other output and continue.

## 7.3 CHANGING OUTPUT SETPOINTS (PID ONLY)

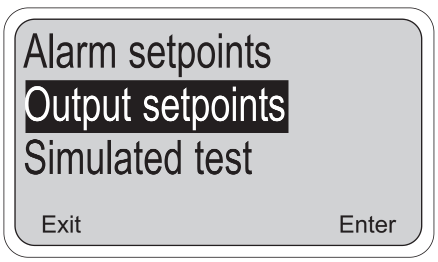
1. This section describes how to assign the setpoint and the upper and lower range values (URV and LRV) when the 54eA is being used for PID control. Assign the LRV to 4 mA and the URV to 20 mA. The LRV is the deviation from the setpoint that will result in a 4 mA output. The URV is the deviation from the setpoint that will result in a 20 mA output.

   Example: The setpoint is 1.00 ppm. The URV is +0.50 and the LRV is 0.00. If the present reading is 1.20 ppm, the output will be (1.20 - 1.00)/(0.50 - 0.00) or 40% of the range (10.40 mA). If the present reading is 1.50 ppm, the output will be (1.50 - 1.00)/(0.50 - 0.00) or 100% of the range (20.00 mA). If the present reading is less than the setpoint, the output will be 4 mA.

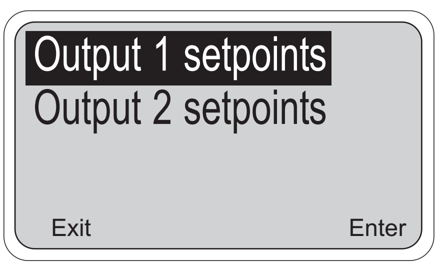
   The control setpoint is usually the condition where the output current is a minimum. The P and I control calculations use the setpoint to adjust the output to the desired level based on the parameters established in Section 7.6.

   **To configure the controller for PID control, see Section 7.6.**

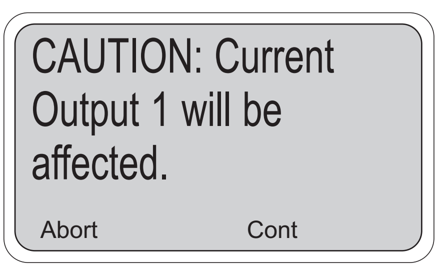
2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).



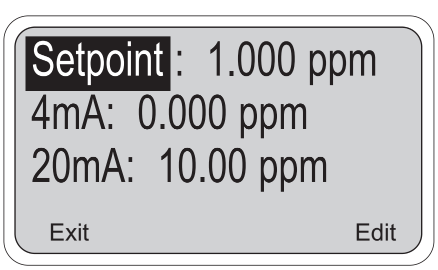

3. Move the cursor to "Output setpoints" and press Enter (F4).




4. Move the cursor to the desired output and press Enter (F4).




5. This screen confirms that changes to output 1 are going to be made. Use caution. Changes may degrade process control. Press Cont (F3) to continue. Otherwise, press Abort (F1).




6. This screen shows the present settings for Output 1. If the output was configured to be 0-20 mA, the second line will show "0mA" instead of "4mA". The live current output is shown on the fourth line. Press the ↓ key once to view the live output.

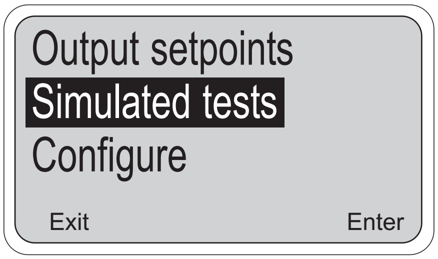
   Move the cursor to the desired line and press Edit (F4). Use the arrow keys to change the value. Press Save (F4) to store the new value.

   Press Exit (F1) to return to the screen in step 4. Choose the other output and continue.

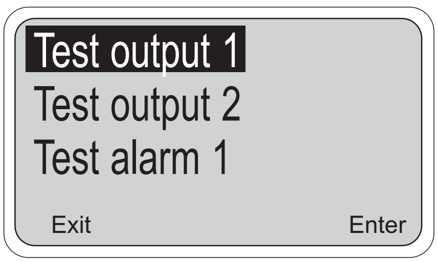
## 7.4 TESTING OUTPUTS AND ALARMS

1. For testing purposes, the controller can be programmed to generate simulated outputs and to activate and deactivate alarms.

2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).

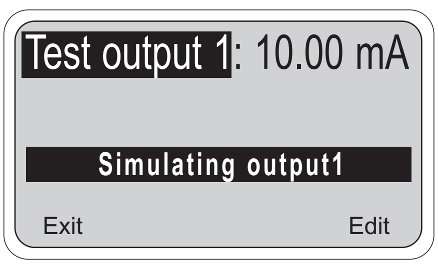



3. Move the cursor to "Simulated tests" and press Enter (F4).




4. Move the cursor to the desired output or alarm. Both outputs and all four alarms can be tested. Press Enter (F4).

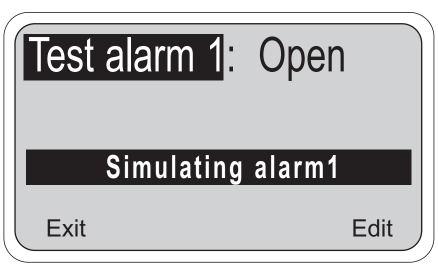
   A screen will appear warning that the output or alarm will change. Press Cont (F3) to continue. Press Abort (F1) to cancel the simulation.




5. This screen appears when an output is being simulated. To change the simulation current, press Edit (F4). Use the arrow keys to change the current to the desired value. Press Test (F4), then Esc (F3).

   The simulated current will be generated for 10 minutes, then the output returns to normal operation. To change the timeout to a different value see Section 7.5.

   To end the simulation at any time, press Exit (F1).




6. This screen appears when an alarm is being simulated. To change the state of the relay, press Edit (F4). Use the ↑ or ↓ keys to change from open to closed. Press Test (F4), then Esc (F3).

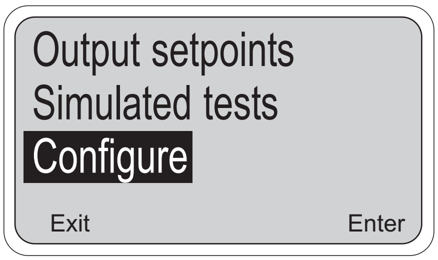
   The alarm will be simulated for 10 minutes, then the alarm returns to normal operation. To change the timeout to a different value, see Section 7.5.

   To end the simulation at any time, press Exit (F1).

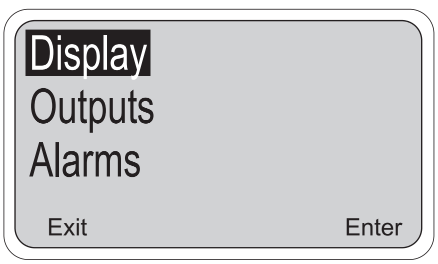
## 7.5 CHOOSING DISPLAY OPTIONS

1. The 54eA controller can be used with any amperometric sensor manufactured by Rosemount Analytical. The default sensor is oxygen. In order to use the controller with a total chlorine sensor, the sensor identification must be changed.
2. The display menu also lets the user customize the third line in the display, change timeout values, choose a language other than English, and change the display contrast.

3. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).




4. Move the cursor to "Configure" and press Enter (F4).



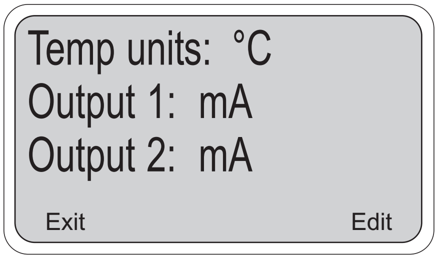

5. With the cursor on "Display", press Enter (F4).

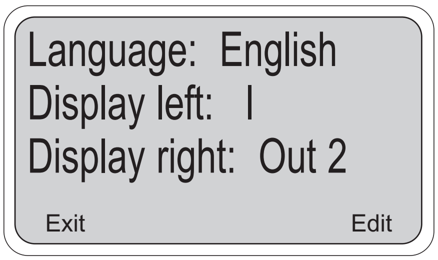
6. A screen showing the present main measurement will appear. To change the measurement to total chlorine, press Edit (F4), then use the ↑ key to scroll through the choices until total chlorine is highlighted. Press Save (F4) to store the setting.

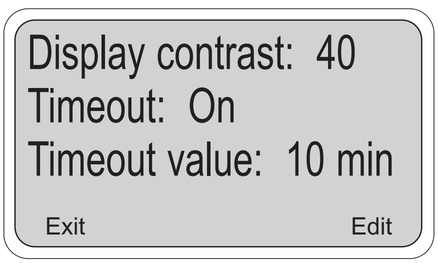
   A screen will appear warning that if the measurement is changed, the analyzer will return to factory default settings. Press Cont (F3) to continue. Press Abort (F1) to cancel the change.

*continued on following page*

# 7.5 CHOOSING DISPLAY OPTIONS (CONTINUED)




7. Set the remainder of the display parameters. Use the ↑ and ↓ keys to choose the desired parameter. Then press Edit (F4). Use the ↑ key to move the cursor to the desired selection. Press Save (F4) to store.

| | |
|---|---|
| Temp units | °C or °F |
| Output 1 | mA or % of full scale |
| Output 2 | mA or % of full scale |
| Language | English, Français, Español, Deutsch, Italiano |
| Display left | sensor current (I), alarm 1 setpoint (no units), alarm 3 setpoint (no units), or blank |
| Display right | sensor current (I), alarm 2 setpoint (no units), alarm 3 setpoint (no units), output 2, or blank |
| Display Contrast | 00 (lightest)-99 (darkest); the display contrast changes as the number changes |
| Timeout | Timeout returns the display from any other screen to the main display if no key is pressed before the timeout value is exceeded. |
| Timeout value | |
| Polling address | Identifies controller in multi-drop HART applications. |

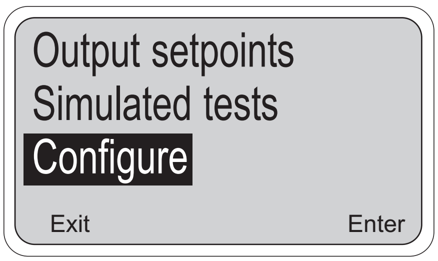
**SECURITY CAUTION**

The controller uses the timeout value to activate security. Once the controller is unlocked by entering a security code, security will not re-activate until a display timeout occurs. If timeout has been turned off, security will never reactivate.

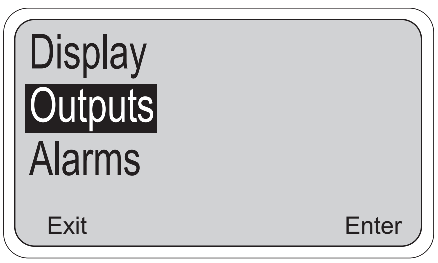
# 7.6 CHANGING OUTPUT PARAMETERS

1. This section describes how to configure the controller outputs. Outputs can be configured to represent total chlorine or temperature.
2. The output can be configured as either a normal or PID output. Normal means the output current is directly proportional to the measurement assigned to the output. PID means the output is used for PID control.

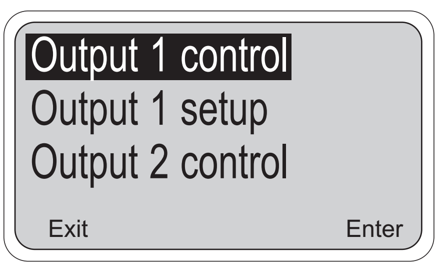
3. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).




4. Move the cursor to "Configure" and press Enter (F4).



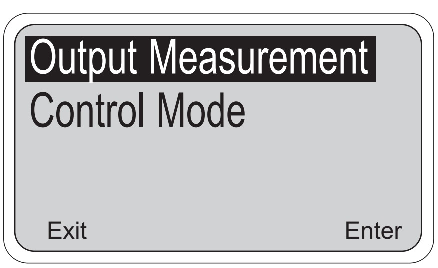

5. Move the cursor to "Outputs" and press Enter (F4).



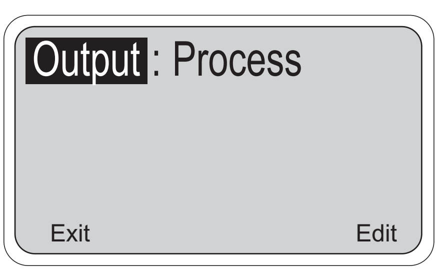

6. Five menu headers relate to outputs. Each output has a control header and a setup header. The fifth header allows the output hold feature to be configured.

   **Always configure the control parameters BEFORE making changes in the output setup.**

   To access a header, move the cursor to the desired header and press Enter (F4).




7. **Output Control Settings:**
   a. Move the cursor to the desired output control header. Press Enter (F4).
   b. With the cursor on "Output Measurement" press Enter (F4).

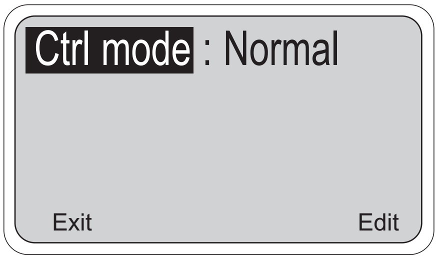



   c. Press Edit (F4).
   d. Use the ↑ key to scroll through the choices: "Process" or "Temperature". "Process" means the measurement made by the

## 7.6 CHANGING OUTPUT PARAMETERS (continued)

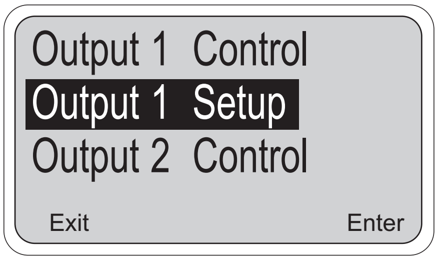
main sensor (total chlorine). Press Save (F4) to store the selection.

e. The display returns to the “Output: Process” screen. Press Exit (F1). The display returns to the “Output Measurement” screen. Move the cursor to "Control mode" and press Enter (F4).

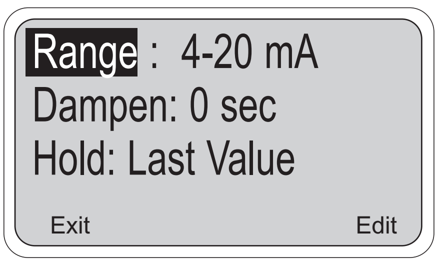



f. Press Edit (F4). Use the ↑ key to toggle between "Normal" and "PID". Press Save (F4) to store the selection.

8. **Output setup for normal outputs:**




a. Move the cursor to the desired output setup and press Enter (F4).




b. Use the ↑ and ↓ arrow keys to move the cursor to the desired parameter. Press Edit (F4). Use the arrow keys to change the setting to the desired value and press Save(F4) to store the value.

**Range:** Choose 4-20 mA or 0-20 mA.

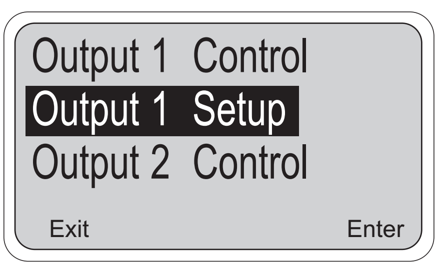
**Dampen:** Dampening averages the output current, thus smoothing out a noisy reading. Higher values provide more smoothing but increase the response time of the output.

**Hold and Fixed Hold:** If the analyzer is placed in hold, the outputs will either remain at the last value or go to a fixed value selected by the user. The fixed value must be between 0 and 22.00 mA.

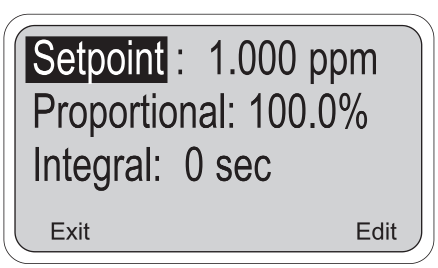
**Fault:** If the analyzer detects a fault, the output will signal the fault by going to a user-selected current between 0 and 22.00 mA.

For allowed values, see Table 7-1.

9. **Output setup for PID outputs:**




a. Move the cursor to the desired output setup and press Enter (F4).




b. Use the ↑ and ↓ keys to move the cursor to the desired parameter. Press Edit (F4). Use the arrow keys to change the setting to the desired value and press Save (F4) to store the value.

**Setpoint:** Setpoint is usually the value at which the process is being controlled. Typically, the output will be 4 mA (or 0 mA) when the value is near the setpoint.

# 7.6 CHANGING OUTPUT PARAMETERS (continued)

**Proportional:** Proportional is the same as proportional band and is the range over which control is being used. It is the opposite of process gain. Smaller values provide tighter control.

**Integral:** Integral is the number of seconds over which deviations from the setpoint are integrated to remove continuing offsets. Smaller values provide higher response.

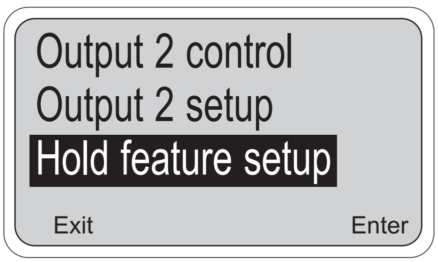
**Derivative:** Derivative is a form of control that resists all changes in readings. Higher readings increase the derivative function. To prevent process oscillation, use caution in setting the derivative value.

**Range:** Choose 4-20 mA or 0-20 mA.

For an explanation of **Hold**, **Fixed Hold**, and **Fault**, see step 8b above.

For allowed values, see Table 7-1.

For more information using PID control, see Section 11.0.




10. **Hold setup.**

a. Move the cursor to "Hold feature setup" and press Enter (F4).

b. Press Edit (F4). Use the ↑ to scroll through the choices: "Disable feature", "Enable feature", and "20 min timeout". If "20 min timeout" is selected, hold mode will automatically disengage after being on for 20 minutes.

**NOTE**

Selecting "Enable hold" or "20-min timeout" does not put the controller in hold. It only allows the user to put the controller in hold when the controller is in calibrate mode.

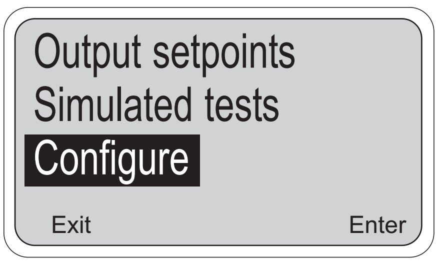
11. **Using hold.**

If hold was enabled in step 10 above, the hold screen will appear as soon as the user enters the Calibrate menu. To activate Hold, press Edit (F4). Use the ↑ key to change Off to On and press Save (F4). "Hold Mode Activated" will be displayed. Outputs and relays will go to the values programmed in step 8b.

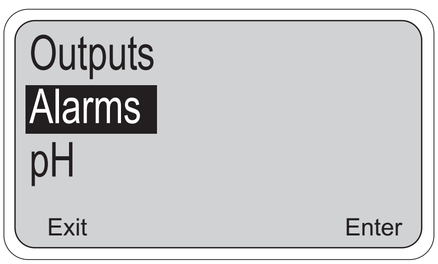
"Hold Mode Activated" will continue to flash in the main display even after the user has left the Calibrate menu. To deactivate hold, enter the Calibrate menu and press Edit (F4). Use the ↑ key to change On to Off and press Save (F4). Press Exit (F1) twice to return to the main display.

# 7.7 CHANGING ALARM PARAMETERS

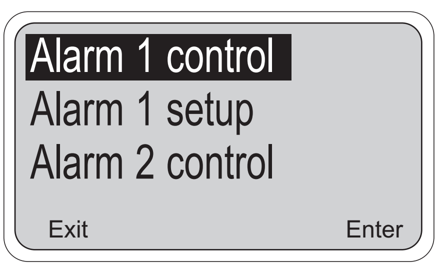
1. This section describes how to configure the controller alarms. Alarms 1, 2, and 3 can be assigned to the main measurement (total chlorine) or temperature. In addition, alarm 1, 2, or 3 can be configured as a feed limit timer or as an interval timer (see steps 10 and 11). Alarm 4 is always a fault alarm.
2. An alarm assigned to the main measurement or temperature can be configured as either a simple on/off alarm or as TPC (time proportional control) alarm.
3. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).




4. Move the cursor to "Configure" and press Enter (F4).



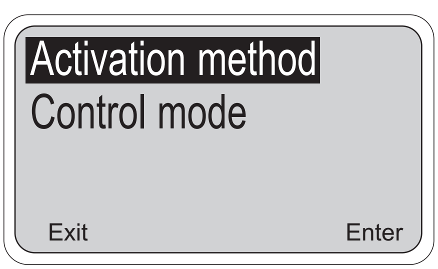

5. Move the cursor to "Alarms" and press Enter (F4).




6. Nine menu headers relate to alarms. Alarms 1, 2 and 3, each have a control header and a setup header. Alarm 4 has only a setup header. The eighth menu header is for configuring the feed limit timer, and the ninth menu header is for configuring the interval timer.

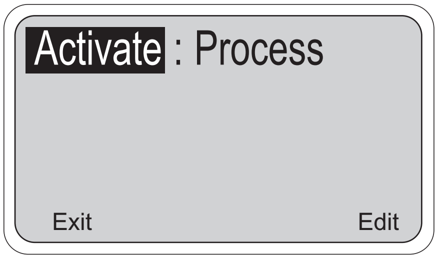
   **Always configure the control parameters BEFORE making changes in the alarm setup.**

   To access a header, move the cursor to the desired header and press Enter (F4).

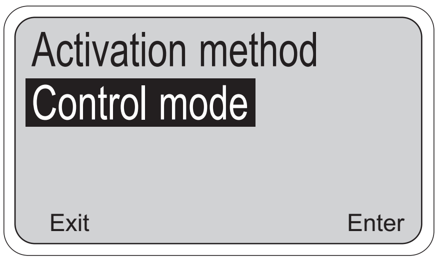



7. **Alarm Control Settings:**
   a. Move the cursor to the desired output control header. Press Enter (F4).
   b. With the cursor on "Activation method" press Enter (F4).

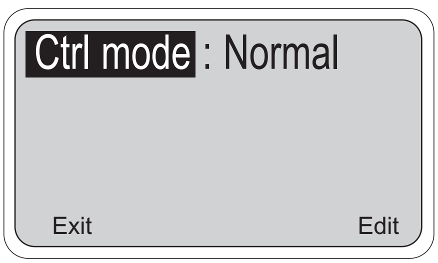
# 7.7 CHANGING ALARM PARAMETERS (continued)



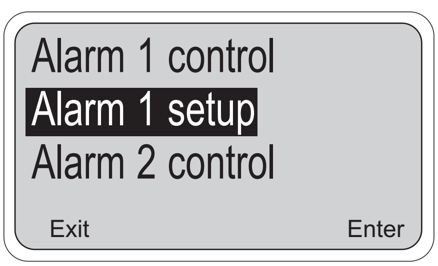

c. To change the activation method, press Edit (F4). Use the ↑ key to scroll through the choices: "Process" or "Temperature". "Process" means the total chlorine measurement. Press Save (F4) to store the selection.




d. The display returns to the "Activate: Process" screen. Press Exit (F1). The display returns to the "Activation method" screen. Move the cursor to "Control mode" and press Enter (F4).

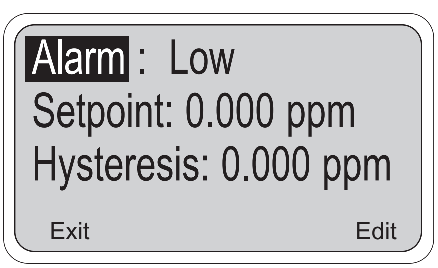



e. To change the control mode, press Edit (F4). Use the ↑ key to toggle between "Normal" and "TPC". Press Save (F4) to store the selection.




8. **Alarm setup for normal alarms:**

   a. Move the cursor to the desired alarm setup and press Enter (F4).




   b. Use the ↑ and ↓ keys to move the cursor to the desired parameter. Press Edit (F4). Use the arrow keys to change the setting to the desired value and press Save (F4) to store the value. See the Figures 7-2 and 7-3 for an explanation of terms: **low alarm**, **high alarm**, **hysteresis**, and **delay**. See Table 7-1 for allowed values and limits.

   **Relay default** determines how the relay will operate if there is a fault or the controller is in hold. Alarms can be forced on (Close), off (Open), or remain unchanged (None).

# 7.7 CHANGING ALARM PARAMETERS (continued)

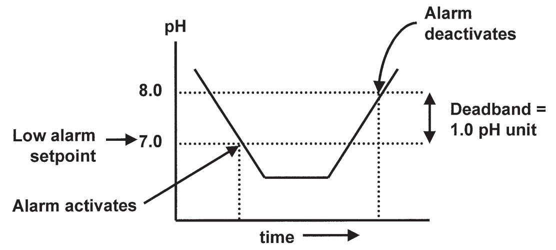



**FIGURE 7-2. Low Alarm**

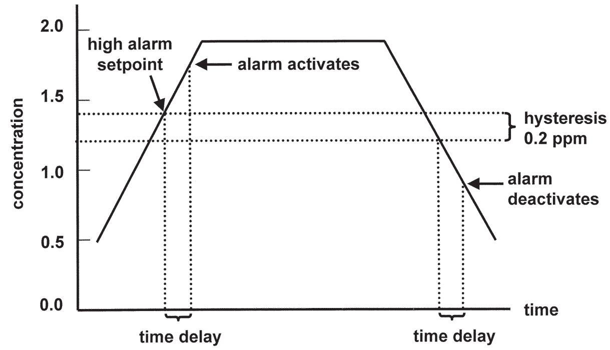
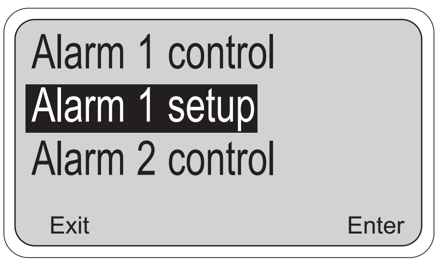
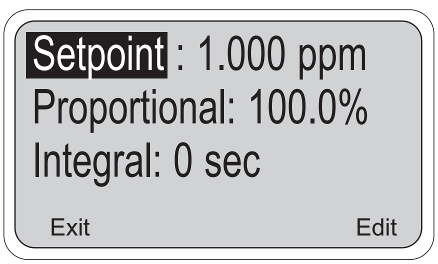



**FIGURE 7-3. High Alarm**

9. **Alarm setup for TPC alarms:**




a. Move the cursor to the desired alarm setup and press Enter (F4).




b. Use the ↑ and ↓ keys to move the cursor to the desired parameter. Press Edit (F4). Use the arrow keys to change the setting to the desired value and press Save (F4) to store the value

**Setpoint:** Setpoint is the usually the value to which the process is to be controlled. The alarm will not be on much when the process is at the setpoint value.

**Proportional:** Proportional is the same as proportional band and is the range over which control is being used. It is the opposite of process gain. Smaller values provide tighter control.

**Integral:** Integral is the number of seconds over which deviations from the setpoint are integrated to remove continuing offsets. Smaller values provide higher response.

**Derivative:** Derivative is a form of control that resists all changes in readings. Higher readings increase the derivative function. To prevent process oscillation, use caution in setting the derivative value.

**Time period:** Time period is the cycle time for TPC control. One cycle consists of an energized (relay on) time and a deenergized (relay off) time.

**URV:** URV is the deviation from the setpoint that results in the alarm being on all the time.

**LRV:** LRV is the deviation from the setpoint that results in the alarm being off all the time. The LRV should be set to 0.00.

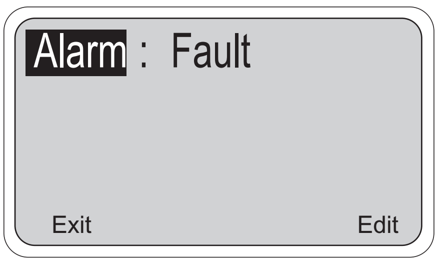
# 7.7 CHANGING ALARM PARAMETERS (continued)

**Example:** The setpoint is 3.00 ppm. The URV is +5.00 ppm and the LRV is 0.00 ppm. The time period is 30 seconds. When the concentration is 4.00 ppm, the relay will be on (4-3)/(5-0) = 20% of the time or 6 seconds.

**Relay default:** Relay default determines how the relay will act if there is a fault or hold condition. The choices are on (relay closed), off (relay open), or none (relay remains unchanged).

**USE OF TPC**

**Setting TPC parameters is not trivial. Substantial trial and error is often needed before results are acceptable. For non-linear measurements, like pH, applying PID algorithms can result in unintended effects.**




9. **Alarm 4 setup:**

   Alarm 4 is a dedicated fault alarm. When a fault condition exists, the red LED on the front display will light.

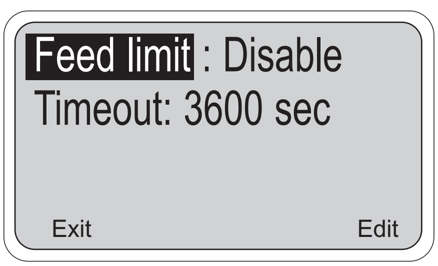
   a. From the menu header screen (step 6) move the cursor to "Alarm 4 setup."

   b. To disable the alarm, press Edit (F4) and use the ↑ key to change the "Fault" to "Off"

10. **Feed limit timer setup:**

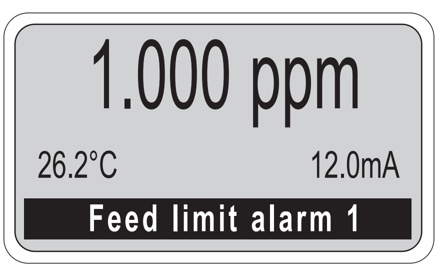
   Alarm 1, 2, or 3 can be configured as a feed limit timer. The feed limit timer prevents overfeeding of treatment chemicals by automatically turning off the relay after a timeout period.

   a. From the menu header screen (step 6) move the cursor to "Feed limit timer." Press Enter (F4).




   b. With the cursor on "Feed limit" press Edit. Use the ↑ key to scroll through the choices: disable, AL 1, AL 2, and AL 3. Press Save (F4) to store the selection.

   c. Move the cursor to "Timeout". Press Edit (F4) and use the arrow keys to change the timeout to the desired value. Press Save (F4) to store the setting.




**Operation of the feed limit timer.** When a feed limit alarm has timed out, "Feed limit alarm 1" (if alarm 1 was chosen) appears in the display. At the same time the red FAIL LED will light and alarm 4 will close (if not turned off), and the selected feed limit relay (alarm 1) will open (de-energize). All other alarms and current outputs will remain unchanged. The relays remain in the state described until the Ack (F2) key is pressed, at which time the controller returns to normal operation and the feed limit clock starts again.

**NOTE**

Pressing Ack (F2) acknowledges all conditions that turn on the red LED. If another event occurs after F2 is pressed, F2 must be pressed again to acknowledge the new event.

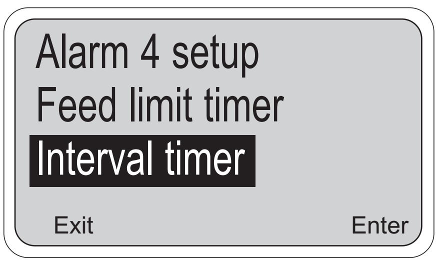
# 7.7 CHANGING ALARM PARAMETERS (continued)

11. **Interval timer setup:**

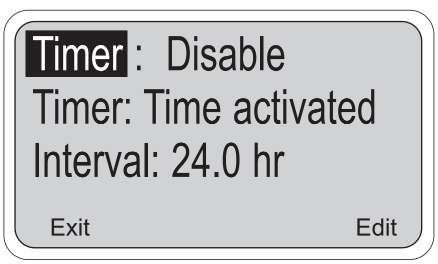
Alarm 1, 2, or 3 can be used as an interval timer. The selected relay will open and close at time intervals programmed by the user. The interval timer is useful for automatic cleaning of sensors.

**NOTE**

The alarm relay used for the interval timer cannot be used for other purposes. When a timer sequence is occurring, both current outputs are placed in hold (even if hold was not enabled) and the other two alarms will be placed in their default states.




a. From the menu header screen (step 6) move the cursor to "Interval timer."




b. With the cursor on "Interval timer", press Enter (F4). Use the ↓ key to scroll through the selections. Use the arrow keys to change settings. Press Save (F4) to store.

Refer to the diagram for definition of terms: **interval**, **repeats**, **on time**, **off time**, and **recovery**.

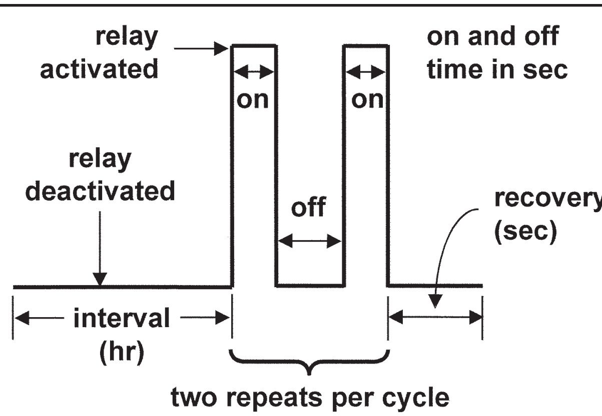


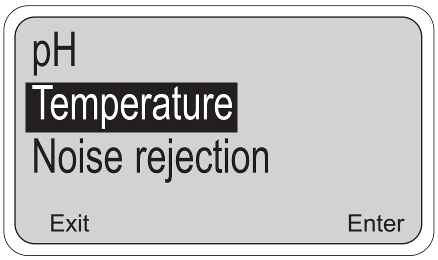

**FIGURE 7-4. Interval Timer**

# 7.8 TEMPERATURE COMPENSATION AND TEMPERATURE UNITS

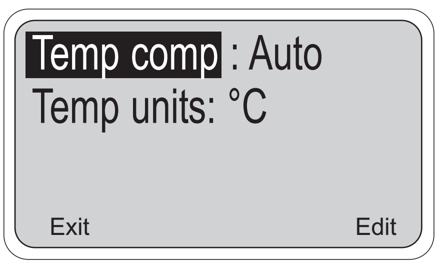
1. Refer to Section 8.1 for a discussion of the ways in which temperature affects the total chlorine measurement.

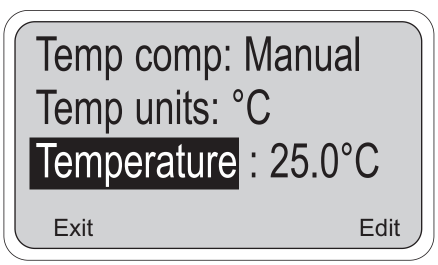
2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).

3. Move the cursor to "Configure" and press Enter (F4).




4. Move the cursor to "Temperature" and press Enter (F4).




5. Use the ↑ and ↓ keys to move through the list of items. To make a change press Edit (F4). Use the arrow keys to change settings to the desired value. Press Save (F4) to store changes.

   **Auto:** In automatic temperature compensation, the controller measures the temperature using an RTD (resistance temperature device). The controller then uses the measured temperature to calculate the membrane permeability correction.

   **Manual:** In manual temperature compensation, the controller uses the temperature entered by the user to calculate the membrane permeability correction. It does **NOT** use the actual process temperature. Do **NOT** use manual temperature compensation unless the difference between the calibration and measurement temperatures is less than 2°C.

   **Manual temperature compensation is useful if the sensor RTD has failed and a replacement sensor is not available.**

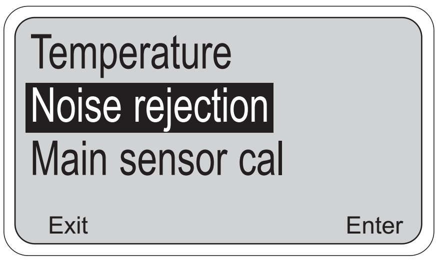
   If Manual temperature compensation is selected, be sure to enter the desired temperature.

# 7.9 NOISE REDUCTION

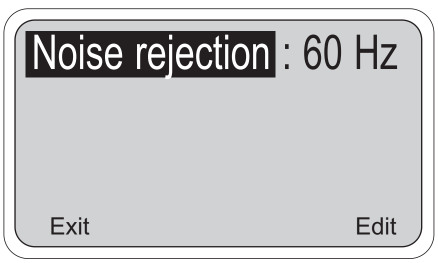
1. For maximum noise reduction the frequency of the ac power must be entered into the analyzer.

2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).

3. Move the cursor to "Configure" and press Enter (F4).




4. Move the cursor to "Noise rejection" and press Enter (F4).




5. To change the frequency setting, press Edit (F4). Use the ↑ key to toggle between 50 and 60 Hz. Press Save (F4) to store the change.

# 7.10 MAIN SENSOR CALIBRATION PARAMETERS

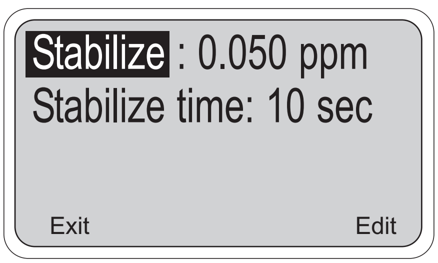
1. Main sensor refers to the total chlorine sensor.

2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).

3. Move the cursor to "Configure" and press Enter (F4).

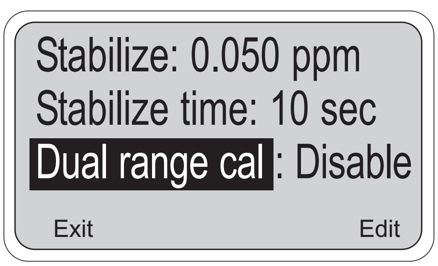

4. Move the cursor to "Main sensor cal" and press Enter (F4).

5. Use the ↑ and ↓ keys to move through the list of items. To make a change press Edit (F4). Use the arrow keys to change settings to the desired value and press Save (F4). For allowed ranges, see Table 7-1.

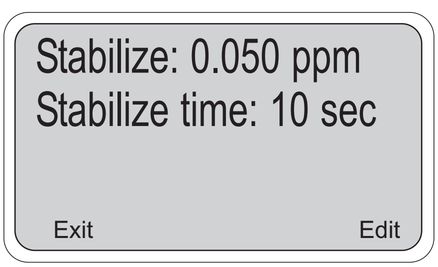



The choices depend on the measurement being made.

**Stabilize and Stabilize time:** For the controller to accept calibration data, the concentration must remain within a specified range for a specified period of time. The default values are 0.05 ppm and 10 seconds. Using a small stabilize value and a long stabilize time is the best protection against calibration while a reading is still changing.




**Dual range cal:** The Model 499ACL-02 total chlorine sensor from Rosemount Analytical can become non-linear at high concentrations of chlorine. Dual range calibration allows the analyzer to correct for the non-linearity of the sensor. For more information see Section 9.4.



# 7.11 SECURITY

1. The controller can be programmed to require a password for access to menus. There are three levels:

   **Level 1:** A level 1 user can
   1. Zero and calibrate the total chlorine sensor
   2. Change temperature compensation from automatic to manual and enter a manual compensation temperature
   3. View diagnostic variables.

   **Level 2:** A level 2 user can
   1. Do everything a level 1 user can do
   2. Change control setpoints for PID current outputs
   3. Change alarm setpoints for normal and TPC alarms
   4. Rerange the 4-20 mA outputs
   5. Manually test both outputs and all four alarm relays.

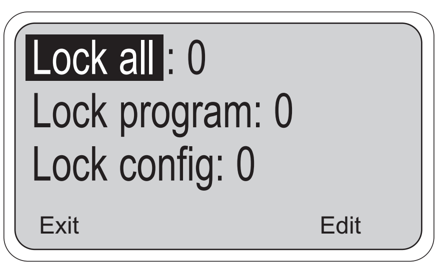
   **Level 3:** A level 3 user has access to every menu item. Only a level 3 user can change passwords.

   A person with no password can only view the main display.

2. Press any key to enter the main menu. Move the cursor to "Program" and press Enter (F4).

3. Move the cursor to "Configure" and press Enter (F4).


4. Move the cursor to "Security" and press Enter (F4).




5. Use the ↑ and ↓ keys to move through the list of items. To enter a password, press Edit (F4). Use the arrow keys to enter a three-digit password. Press Save (F4) to store the value.

   **Lock all:** Until the user enters the "lock all" password, all he can do is view the main display. Entering the "lock all" password allows the user access to all Level 1 functions.

   **Lock program:** Entering the "lock program" password allows the user access to all Level 2 functions.

   **Lock config:** Entering the "lock config" password allows the user access to all Level 3 functions.

   The controller will accept a higher level security code at a lower level security gate. For example, the controller will accept a level 2 password at a level 1 gate.

NOTES:

a. A code of 000 disables security for that level.
b. The security feature will not activate until after the timeout period has passed with no key presses.
c. A hold condition will indefinitely prolong the timeout period.
d. Security will activate immediately if power is removed and then restored.
e. To recall a forgotten code, press and hold F4 for five seconds when the security screen appears. The code for that level will appear.

# 7.12 CONTROLLER MODE PRIORITY

The Model 54eA controller can function in different modes depending on both how it is configured, what process conditions exist, and actions an operator may have made. To reconcile these possible modes, there is a set priority that determines exactly what will happen to the two (2) current outputs and the four (4) alarm relays in the event of multiple modes occurring at the same time. See Table 7-2 below.

Priority is in the following order (from lowest to highest): normal, fault, timer, hold, feed limit, test. Each output or relay acts as if it is only in the state of highest priority.

**NOTE**

Some of these features may not be in use in the controller.

## TABLE 7-2. Controller Mode Priority Chart

| Condition | Priority | Current Output 1 | Current Output 2 | Alarm Relay 1 | Alarm Relay 2 | Alarm Relay 3 | Alarm Relay 4 |
|---|---|---|---|---|---|---|---|
| Normal | **1** | Normal | Normal | Normal | Normal | Normal | Open |
| Fault | **2** | Default | Default | Default | Default | Default | Closed |
| Interval Timer | **3** | Hold | Hold | Default/ Normal[1] | Default/ Normal[1] | Default/ Normal[1] | Prior |
| Hold Mode | **4** | Hold | Hold | Default | Default | Default | Prior |
| Feed Limit | **5** | Normal | Normal | Open[1] | Open[1] | Open[1] | Closed |
| Simulate tests | **6** | Test[1] | Test[1] | Test[1] | Test[1] | Test[1] | Test[1] |

[1] Indicates the state **IF** that item has been configured or selected (i.e. if it is an interval timer or a feed limit timer or it is the one being tested). Unconfigured or unselected items are not affected by that mode.

**Condition Definitions:**

1. Normal refers to conditions when no other mode is present.
2. Fault means the instrument has diagnosed a fault condition. A fault message is displayed and the red LED is on.
3. Interval Timer means the timer sequence is occurring.
4. Hold Mode occurs when hold is activated by the operator (i.e. during calibration).
5. Feed Limit occurs when a feed limit timer has reached its limit and is turned off after being on for too long.
6. Simulate tests are described in Section 7.4.

**Action Definitions:**

1. Normal is determined by process conditions or how the item has been configured (Section 7.6)
2. Open is a deenergized alarm relay (alarm off).
3. Default is the setting configured for each item if there is a fault. (Section 7.6)
4. Closed is an energized alarm relay (alarm on).
5. Hold is the setting for the current output configured in Section 7.5 (fixed mA value or the last normal value).
6. Prior is the state the alarm had before that mode occurred.
7. Test is the value input by the operator (mA for current, on or off for a relay).

# SECTION 8
# CALIBRATION - TEMPERATURE

## 8.1 INTRODUCTION

As explained in Section 2, the total chlorine sensor really measures iodine. The iodine is formed by the reaction between total chlorine in the sample and the acetic acid/iodide reagent continuously injected into it by the sample conditioning system. The total chlorine sensor belongs to a general class of sensors called membrane-covered amperometric sensors. As the sensor operates, iodine diffuses through the membrane and is consumed at an electrode immediately behind the membrane. The reaction produces a current that depends on the rate of diffusion through the membrane. The diffusion rate, in turn, depends on the concentration of iodine and how easily it passes through the membrane (the membrane permeability). Because the membrane permeability is a function of temperature, the sensor current will change if the temperature changes. To correct for changes in sensor current caused by temperature, the controller automatically applies a membrane permeability correction. The permeability changes about 3%/°C at 25°C, so a 1°C error in temperature produces about a 3% error in the reading.

Without calibration the accuracy of the temperature measurement is about ±0.4°C. Calibrate the controller if

1. ±0.4°C accuracy is not acceptable
2. the temperature measurement is suspected of being in error. Calibrate temperature by making the controller reading match the temperature measured with a standard thermometer.

## 8.2 TEMPERATURE CALIBRATION

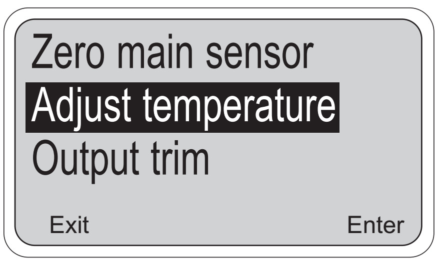
Place the sensor and a standard thermometer in the process liquid.

1. Check the controller temperature reading (main display) to make sure the sensor has stabilized. Compare the controller temperature with the standard thermometer. The readings should differ by at most 1°C. If the readings differ by a greater amount, refer to Section 13.3. Go to the next step if the reading requires adjustment.

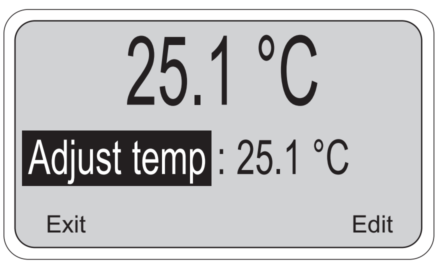
2. From the main display, press any key. With the cursor on “Calibrate,” press Enter (F4).

**NOTE**

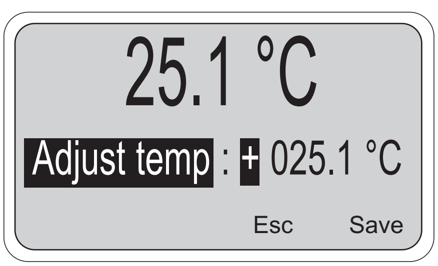
If Hold was enabled in Section 7.6, the hold screen will appear. To activate hold, refer to Section 7.6, step 11.




3. Press the ↓ key twice to move the cursor to “Adjust temperature,” then press Enter (F4).




4. Press Edit (F4) to adjust the temperature. The screen below will then appear. Using the arrow keys, enter the correct temperature and press Save (F4). The controller will enter the value in memory. To abort the change, press Esc (F3). Press Exit (F1) three times for the main display.




**NOTE**

If Hold was activated during calibration, “Hold Mode Activated” will continue to flash in the main display. Return the sensor to normal and deactivate Hold. Refer to Section 7.6, step 11.

# SECTION 9
# CALIBRATION - TOTAL CHLORINE

## 9.1 INTRODUCTION

The continuous determination of total chlorine requires two steps. See Figure 9-1. First, the sample flows into a conditioning system (Model TCL) where it is treated with acetic acid (vinegar) and potassium iodide. The acid lowers the pH, which allows total chlorine in the sample to quantitatively oxidize the iodide to iodine. The treated sample then flows to the sensor. The sensor is a membrane-covered amperometric sensor, whose output is proportional to the concentration of iodine. Because the concentration of iodine is proportional to the concentration of total chlorine, the analyzer can be calibrated to read total chlorine.

Figure 9-2 shows a typical calibration curve for a total chlorine sensor. Because the sensor really measures iodine, calibrating the sensor requires exposing it to a solution containing no iodine (zero standard) and to a solution containing a known amount of iodine (full-scale standard).

The zero standard is necessary because the sensor, even when no iodine is present, generates a small current called the residual current. The analyzer compensates for the residual current by subtracting it from the measured current before converting the result to a total chlorine value. New sensors require zeroing before being placed in service, and sensors should be zeroed whenever the electrolyte solution is replaced. Deionized water is a good zero standard.

The purpose of the full-scale standard is to establish the slope of the calibration curve. Because stable total chlorine standards do not exist, the sensor must be calibrated against a test run on a grab sample of the process liquid. Several manufacturers offer portable test kits for this purpose. Observe the following precautions when taking and testing the grab sample.

- Take the grab sample from a point as close as possible to the inlet of the TCL sample conditioning system.
- Total chlorine solutions are unstable. Run the test immediately after taking the sample. Try to calibrate the sensor when the chlorine concentration is at the upper end of the normal operating range.

The Model 499ACL-02 (total chlorine) sensor loses sensitivity at high concentrations of chlorine. The 54eA controller has a dual slope feature that allows the user to compensate for the non-linearity of the sensor. However, for the vast majority of applications, dual slope calibration is unnecessary.

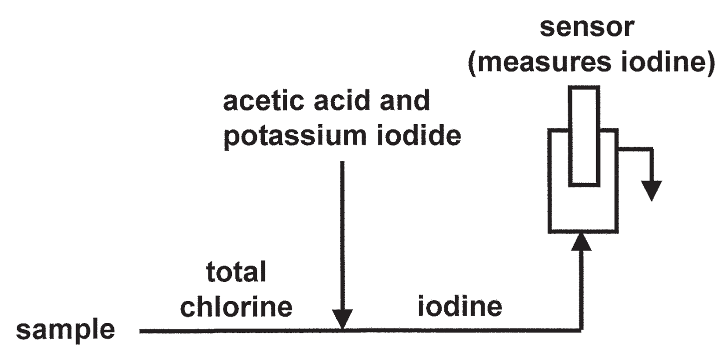



FIGURE 9-1. Determination of Total Chlorine

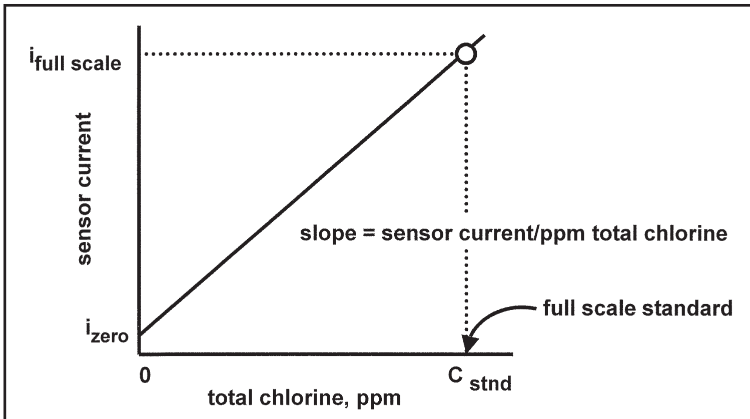
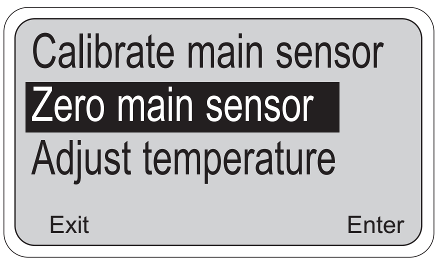



FIGURE 9-2. Sensor Current as a Function of Total Chlorine Concentration

## 9.2 ZEROING THE SENSOR

1. Place the sensor in a beaker of dionized water.
2. Let the system run until the sensor current is stable. The sensor current will drop rapidly at first and then gradually reach a stable zero value. To monitor the sensor current, go to the main display. Press any key to obtain the main menu. Press the ↓ key once to highlight “Diagnostic variables.” Press Enter (F4). The sensor current is the second item in the display. Note the units: nA is nanoamps, $\mu$A is microamps. To return to the main display, press exit (F1) twice. Typical zero current for a total chlorine sensor is -10 to +30 nA.

   A new sensor or a sensor in which the electrolyte solution has been replaced may require several hours (occasionally as long as overnight) to reach a minimum zero current. DO NOT START THE ZERO ROUTINE UNTIL THE SENSOR HAS BEEN IN ZERO SOLUTION FOR AT LEAST TWO HOURS.

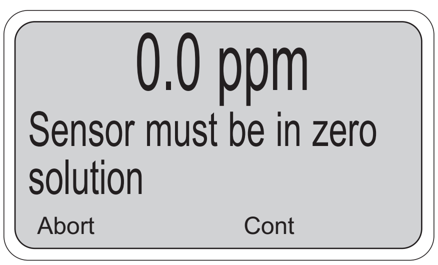



3. From the main display, press any key to obtain the main menu. With the cursor on “Calibrate,” press Enter (F4).

   **NOTE**

   If Hold was enabled in Section 7.6, the hold screen will appear. To activate hold, refer to Section 7.6, step 11.

   Press the ↓ key once to move the cursor to “Zero main sensor.” Press Enter (F4).




4. The screen at left appears. Press Cont (F3). “Wait” flashes until the sensor is stabilized. Once the zero step is complete, the message “Sensor zero done” appears.
5. Press Exit (F1) three times to return to the main display.

**NOTE**

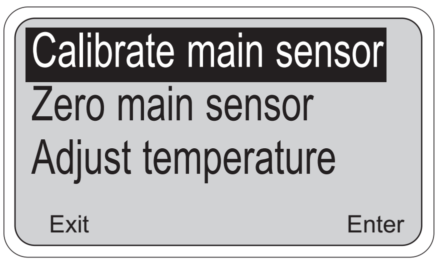
If Hold was activated during calibration, “Hold Mode Activated” will continue to flash in the main display. Return the sensor to normal and deactivate Hold. Refer to Section 7.6, step 11.

**NOTE**

During calibration, ERROR and WARNING messages may appear. If an ERROR message appears, press Exit (F1) to leave and return to the previous screen. If a WARNING message appears, press Cont (F3) to continue the calibration or press Abort (F1) to leave. Continuing the calibration after a warning message appears may cause substantial errors in the subsequent measurement. Refer to Section 13.3 for assistance.

# 9.3 FULL SCALE CALIBRATION

1. If the sensor was just zeroed, place the sensor back in the flow cell. Confirm that excess sample is flowing down the inside tube of the overflow sampler. Also, verify that reagent is being delivered to the sample and the air pump is working.
2. Adjust the chlorine concentration until it is near the upper end of the control range. Wait until the controller reading is stable before starting the calibration. When the TCL is first started up or when a new sensor is put in service, allow at least 30 minutes for the reading to stabilize.




3. From the main display, press any key to obtain the main menu. With the cursor on “Calibrate,” press Enter (F4).

**NOTE**

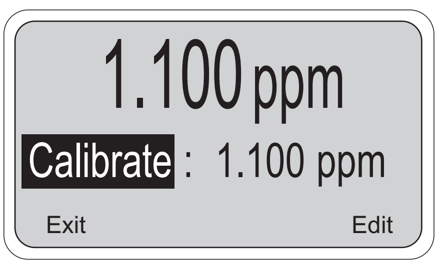
If Hold was enabled in Section 7.6, the hold screen will appear. To activate hold, refer to Section 7.6, step 11.

Press Enter (F4).


4. Press Cont (F3). “Wait” flashes until the sensor is stabilized.

   If the controller appears locked, the reading is not stable enough. Wait until the process readings are stable before starting the calibration.

   Alternatively, increase the stability concentration or reduce the stability time. See Section 7.11. Calibrating while readings are unstable may substantially reduce accuracy.




5. Once the reading is stable, the screen at left appears. Sample the process liquid. Make a note of the reading before taking the sample. Immediately determine total chlorine. Note the controller reading again. If the present reading (X) differs from the reading when the sample was taken (Y), calculate the value to enter (C) from the following formula:

$$C = (X/Y)\ (A)$$

   where A is the concentration of chlorine measured in the grab sample.

   Press Edit (F4). Use the arrow keys to change the concentration in the second line of the display to the desired value. Press Save (F4) to store the value.

6. Press Exit (F1) four times to return to the main display.

**NOTE**

If Hold was activated during calibration, “Hold Mode Activated” will continue to flash in the main display. Return the sensor to normal and deactivate Hold. Refer to Section 7.6, step 11.

7. During the calibration, the analyzer stores the measured current and calculates the sensitivity. Sensitivity is the sensor current in nA divided by the measured concentration. The sensitivity of the 499ACL-02 (total chlorine) sensor is about 1300 nA/ppm at 25°C.

   To view the sensitivity from the main display, press any key to enter the main menu. Press the ↓ key once. Then press Enter (F4) to display the diagnostic variables. The sensitivity is the third line on the screen. Note the units: nA is nanoamps, μA is microamps.

**NOTE**

During calibration, ERROR and WARNING messages may appear. If an ERROR message appears, press Exit (F1) to leave and return to the previous screen. If a WARNING message appears, press Cont (F3) to continue the calibration or press Abort (F1) to leave. Continuing the calibration after a warning message appears may cause substantial errors in the subsequent measurement. Refer to Section 13.3 for assistance.

## 9.4 DUAL SLOPE CALIBRATION

Figure 9-3 shows the principle of dual slope calibration. Between zero and concentration C1, the sensor response is linear. When the concentration of chlorine becomes greater than C1, the response is non-linear. In spite of the non-linearity, the response can be approximated by a straight line between point 1 and point 2.

Dual slope calibration is rarely needed. It is probably useful in fewer than 5% of applications.

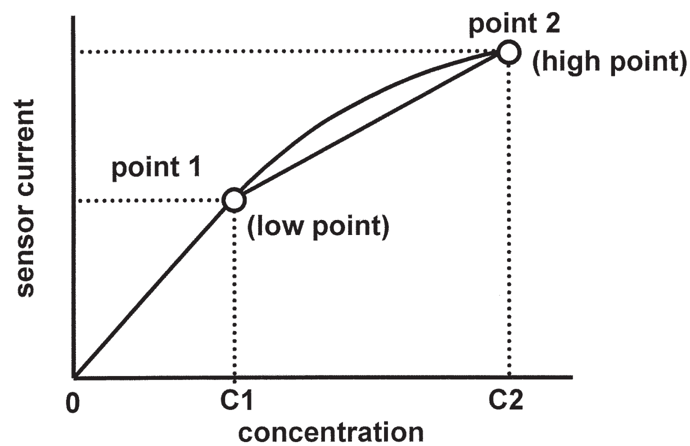
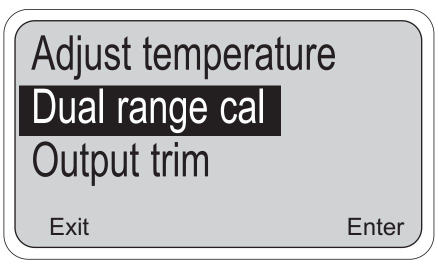



**FIGURE 9-3. Dual Slope Calibration**

1. Be sure the analyzer has been configured for dual slope calibration. See Section 7.11.
2. Zero the sensor. See Section 9.2.
3. Place the sensor back in the flow cell. Confirm that excess sample is flowing down the inside tube of the overflow sampler. Also, verify that reagent is being delivered to the sample and the air pump is working.

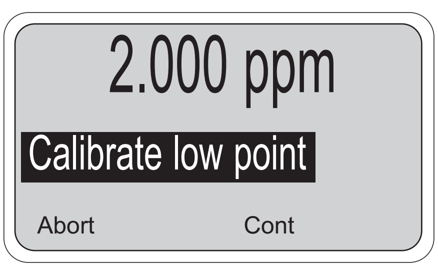



4. From the main display, press any key to obtain the main menu. With the cursor on “Calibrate,” press Enter (F4).

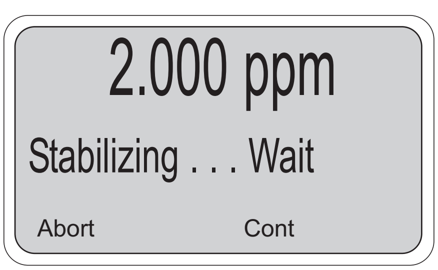
   **NOTE**

   If Hold was enabled in Section 7.6, the hold screen will appear. To activate hold, refer to Section 7.6, step 11.

   Press the ↓ key three times to move the cursor to “Dual range cal.” Press Enter (F4).

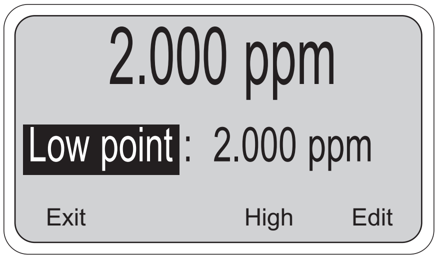



5. Adjust the concentration of chlorine in the process until it is near the upper end of the linear response range of the sensor, i.e., concentration near C1 as shown in Figure 9-3.




6. Press Cont (F3). “Wait” flashes until the sensor is stabilized.

   If the controller appears locked, the reading is not stable enough. Wait until the process readings are stable before starting the calibration.



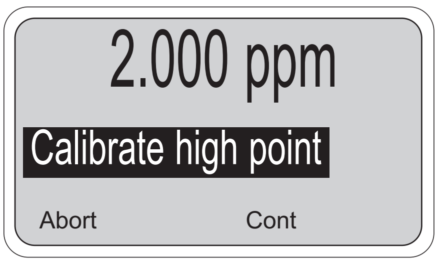

7. Once the reading is stable, the screen at left appears.

   Sample the process liquid. Make a note of the reading before taking the sample. Immediately determine total chlorine. Note the controller reading again. If the present reading (X) differs from the reading when the sample was taken (Y), calculate the value to enter (C) from the following formula:

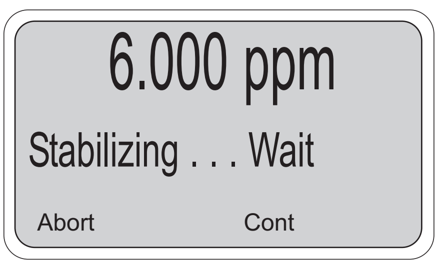
   $$C = (X/Y)\,(A)$$

   where A is the concentration of chlorine measured in the grab sample.

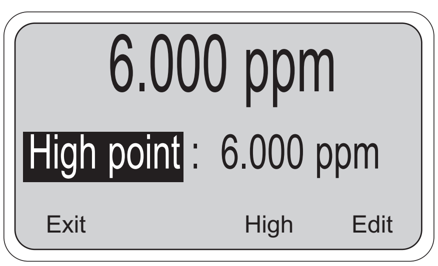
   Press Edit (F4). Use the arrow keys to change the concentration in the second line of the display to the desired value. Press Save (F4) to store the value.




8. Press High (F3). Adjust the concentration of chlorine in the process until it is near the top end of the range, i.e., concentration near C2 as shown in Figure 9-3.




9. Press Cont (F3). “Wait” flashes until the sensor is stabilized.




10. Once the reading is stable, the screen at left appears. Following the procedure in step 7, determine chlorine in a sample of the process liquid.

    Press Edit (F4). Use the arrow keys to change the concentration in the second line of the display to the desired value. Press Save (F4) to store the value.

11. Press Exit (F1) three times to return to the main display.

    **NOTE**

    If Hold was activated during calibration, “Hold Mode Activated” will continue to flash in the main display. Return the sensor to normal and deactivate Hold. Refer to Section 7.6, step 11.

**NOTE**

During calibration, ERROR and WARNING messages may appear. If an ERROR message appears, press Exit (F1) to leave and return to the previous screen. If a WARNING message appears, press Cont (F3) to continue the calibration or press Abort (F1) to leave. Continuing the calibration after a warning message appears may cause substantial errors in the subsequent measurement. Refer to Section 13.3 for assistance.

# SECTION 10
# CALIBRATION - CURRENT OUTPUTS

## 10.1 INTRODUCTION

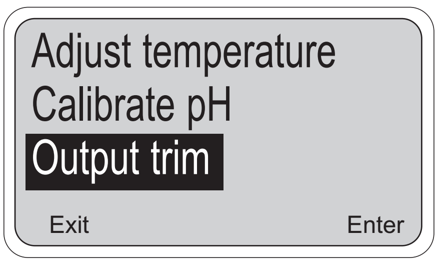
Although the controller outputs are calibrated at the factory, they can be trimmed in the field to match the reading from a standard current meter. Both the low output (0 or 4 mA) and the high output (20 mA) can be trimmed.

## 10.2 TRIMMING THE OUTPUTS

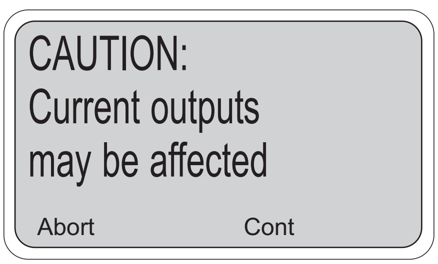
1. From the main display, press any key to obtain the main menu. With the cursor on "Calibrate" press Enter (F4).

**NOTE**

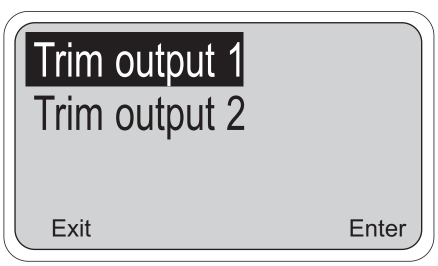
If Hold was enabled in Section 7.6, the hold screen will appear. To activate hold, refer to Section 7.6, step 11.



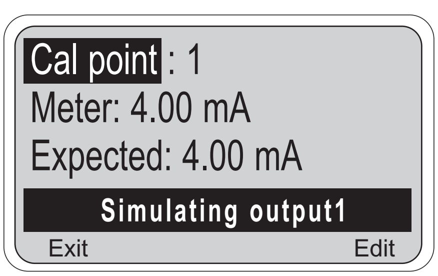

2. Move the cursor to "Output trim” and press Enter (F4).




3. The warning screen reminds the user that the output currents will be affected. Pres Cont (F3) to continue.




4. Use the ↑ or ↓ keys to move the cursor to the desired output and press Enter (F4).




5. Select “Cal point 1” (0 or 4 mA) or “Cal point 2” (20 mA).

6. Move the cursor to “Meter” and press Enter (F4). Measure the output current with a calibrated ammeter. Use the ↑ or ↓ keys to change the display to match the ammeter reading and press Save (F4).

7. Move the cursor to the other “Cal point” and select it. Repeat step 6.

**NOTE**

If Hold was activated during calibration, “Hold Mode Activated” will continue to flash in the main display. Return the sensor to normal and deactivate Hold. Refer to Section 7.6, step 11.

# SECTION 11
# PID AND TPC CONTROL

## 11.1 PID CONTROL (CODE -20)

### PID Control

The Model 54eA current outputs can be programmed for PID control. PID control is used with a control device that is capable of varying its output from 0 to 100 percent in response to a changing signal in milliamps. Automated control valves or variable volume pumps are commonly used. These devices are referred to as modulating control devices because of their 0 to 100% adjustability. PID control is typically used where greater accuracy than is achievable with an on/off device is required, or where it is desirable to have the pump or valve "on" continuously, or where the existing or preferred pump or valve is of the modulating type.

Any process control system must manually or automatically hold the controlled variable (pH, concentration, temperature) in a steady condition at selected set point values. For manual control, the operator looks at the value of the process variable, decides whether or not it is correct, and makes necessary adjustments. He decides the amount, direction, rate of change and duration of the adjustment. With automatic control, the controller does all of this. The operator only adjusts the set point of the controller to the selected value of the measured variable. Automatic process control such as PID is usually feedback control; it eliminates the deviation between measurement and set point based on continuous updates (feedback) from the process itself.

### Measurement and Set Point (Feedback Control)

The Model 54eA controller is given two items of information: measurement and set point. The controller reacts to the difference in value of these two signals and produces an analog output signal to eliminate that difference. As long as the difference exists, the controller will try to eliminate it with the output signal. When measurement and set point are equal, the condition of the controller is static and its output is unchanged. Any deviation of measurement from set point will cause the controller to react by changing its output signal.

### PID Control Mode Combinations

All PID controllers have several control modes which can be used in various combinations: proportional plus integral (reset), proportional plus derivative (rate) and a combination of proportional (P), integral (I) and derivative (D). Each control mode produces a response to the deviation of measurement from set point that is the result of a specific characteristic of the deviation, and each control mode is separately adjustable. D, the derivative, or rate mode, is seldom used in water treatment and is beyond the scope of this manual.

### Proportional Mode (Gain)

The simplest control is proportional. Proportional may also be referred to as sensitivity or gain. Although these terms may refer to a different version of proportional, the control function is still fundamentally the same - the error from set point is multiplied by this factor to produce the output.

**In the Model 54eA controller, proportional mode is referred to as proportional "band" which is configurable from 0 to 299%.** For good control of a specific process, the proportional band must be properly adjusted. The proportional band is the percent of the analog output span (the difference between the 4 (or 0) mA and 20 mA settings) through which the measured variable must move to change the output from minimum to maximum. **The larger the proportional band, the less the controller reacts to changes in the measured variable. As the proportional band is made smaller, the reaction of the controller increases.** At 0 proportional band, the proportional-only controller behaves like an on/off controller (an alarm set at 20 mA).

Most processes require that the measured variable be held at the set point. The proportional mode alone will not automatically do this. Proportional alone will only stabilize the measured variable at some offset to the actual control point. To control at an exact setpoint, proportional plus integral mode is used.

### Proportional (Gain) Plus Integral (Reset)

For the automatic elimination of deviation, I (Integral mode), also referred to as Reset, is used. The proportional function is modified by the addition of automatic reset. With the reset mode, the controller continues to change its output until the deviation between measurement and set point is eliminated.

The action of the reset mode depends on the proportional band. The rate at which it changes the controller output is based on the proportional band size and the reset adjustment. **The reset time is the time required for the reset mode to repeat the proportional action once. It is expressed as seconds per repeat, adjustable from 0-2999 seconds.**

The reset mode repeats the proportional action as long as an offset from the set point exists. Reset action is cumulative. The longer the offset exists, the more the output signal is increased.

The controller configured with reset continues to change until there is no offset. If the offset persists, the reset action eventually drives the controller output to its 100% limit - a condition known as **"reset windup"**. To prevent reset windup, a controller with reset mode should never be used to control a measured variable influenced by uncorrectable conditions. Once the controller is "wound up", the deviation must be eliminated or redirected before the controller can unwind and resume control of the measured variable. The integral time can be cleared and the "windup" condition quickly eliminated by **manually overriding the analog output using the simulate tests feature (detailed in Section 6.4).**

### Control Loop Adjustment and Tuning

There are several methods for tuning PID loops including: Ziegler-Nichols frequency response, open loop step response, closed loop step response, and trial and error. Described in this section is a form of the open loop response method called the process reaction curve method. The reaction times and control characteristics of installed equipment and real processes are difficult to predict. The process reaction curve method of tuning works well because it is based on the response of the installed system. This procedure, outlined in the following paragraphs, can be used as a starting point for the **P** and **I** settings. Experience has shown that PID controllers will do a fair job of controlling most processes with many combinations of reasonable control mode settings.

### Process Reaction Curve Method

A PID loop can be tuned using the process reaction curve method. This method involves making a step change in the chemical feedrate (usually about 50% of the pump or valve range) and graphing the response of the Model 54eA controller reading versus time.

The process reaction curve graphically shows the reaction of the process to step change in the input signal. Figure 11-1 shows an example of a tuning process for a pH controller. Similar results can be obtained for the oxygen, ozone, or chlorine controller.

To use this procedure with a Model 54eA controller and a control valve or metering pump, follow the steps outlined below.

Wire the controller to the control valve or metering pump. Introduce a step change to the process by using the simulate test function to make the step change in the output signal.

Graph the change in the measured variable (concentration or pH) as shown in Figure 11-1. Observe the reading on the Model 54eA controller and note values at intervals timed with a stop watch. A strip chart recorder can be used for slower reacting processes. To collect the data, perform the following steps:

1. Let the system come to a steady state where the measured variable (pH, concentration or temperature) is relatively stable.
2. Observe the output current on the main display of the controller.
3. Using the simulate test, manually set the controller output signal at the value which represented the stable process measurement observed in step 1, then observe the process reading to ensure steady state conditions (a stable process measurement).
4. Using the simulate test, cause a step change in the output signal. This change should be large enough to produce a significant change in the measured variable in a reasonable amount of time, but not too large to drive the process out of desired limits.
5. The reaction of the system, when graphed, will resemble Figure 11-1, showing a change in the measured variable over the change in time. After a period of time (the process delay time), the measured variable will start to increase (or decrease) rapidly. At some further time the process will begin to change less rapidly as the process begins to stabilize from the imposed step change. It is important to collect data for a long enough period of time to see the process begin to level off to establish a tangent to the process reaction curve.

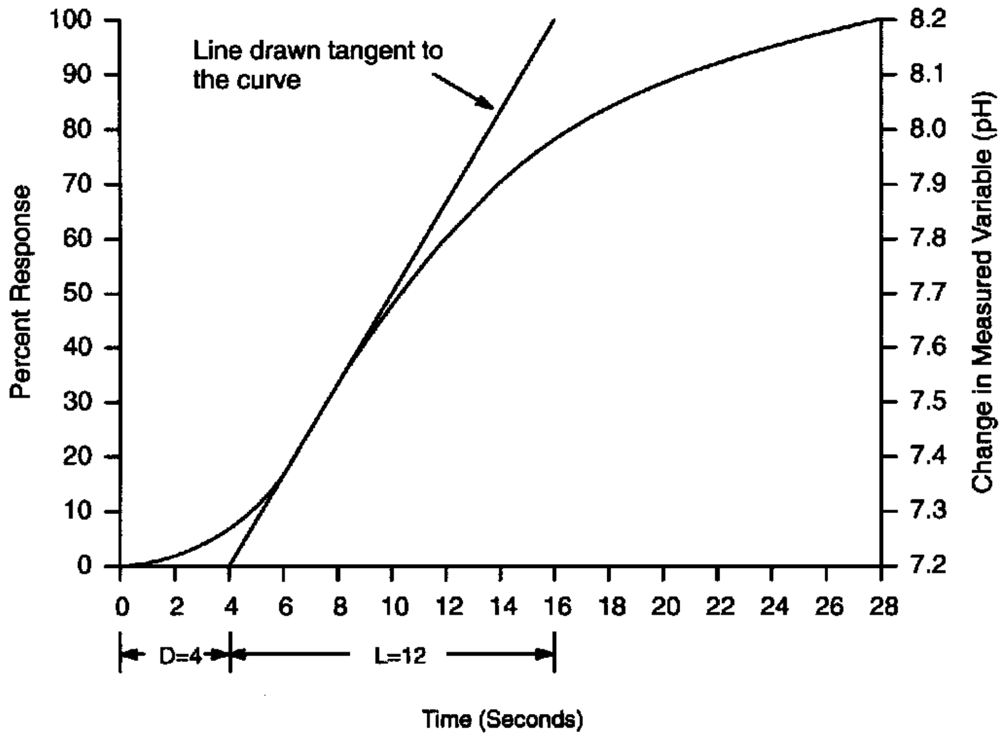



**FIGURE 11-1. The Process Reaction Curve**

6. When sufficient data have been collected, return the output signal to its original value using the simulate test function. Maintain the controller in this manual mode until you are ready to initiate automatic PID control, after you have calculated the tuning constants.

Once these steps are completed, the resulting process reaction curve is used to obtain information about the overall dynamics of the system. It will be used to calculate the needed tuning parameters of the Model 54eA controller.

**NOTE**

The tuning procedure outlined below is adapted from "Instrumentation and Process Measurement and Control", by Norman A. Anderson, Chilton Co., Radnor, Pennsylvania, ©1980.

Information derived from the process reaction curve will be used with the following empirical formulas to predict the optimum settings for proportional and integral tuning parameters.

Four quantities are determined from the process reaction curve for use in the formulas: time delay (D), time period (L), a ratio of these two (R), and plant gain (C).

A line is drawn on the process reaction curve tangent to the curve at point of maximum rise (slope) as shown in Figure 11-1. The Time Delay (D), or lag time, extends from "zero time" on the horizontal axis to the point where the tangent line intersects the time axis. The Response Time period (L), extends from the end of delay period to the time at which the tangent line intersects the 100% reaction completion line representing the process stabilization value. The ratio (R) of the Response Time period to the Time Delay describes the dynamic behavior of the system.

In the example, the process Delay Time (D) was four seconds and the Response Time period (L) was 12 seconds, so:

$$R = \frac{L}{D} \quad \frac{12 \text{ seconds}}{4 \text{ seconds}} = 3$$

The last parameter used in the equations is a plant gain (C). The plant gain is defined as a percent change in the controlled variable divided by the percent change in manipulated variable; in other words, the change in the measured variable (pH, conductivity, temperature) divided by the percent change in the analog output signal.

The percent change in the controlled variable is defined as the change in the measured variable (pH, concentration, temperature) compared to the measurement range, the difference between the 20 mA (Hi) and 4 (or 0) mA (Lo) setpoints, which you determined when configuring the analog output.

In the example shown in Figure 11-1:

The percent change in pH was:

$$\frac{\text{pH2 - pH1}}{\text{pH “Hi” - pH “Lo”}} \times 100\% = \frac{8.2 - 7.2 \text{ pH}}{9.0 - 6.0 \text{ pH}} = 33.3\%$$

The change in the output signal was:

$$\frac{6 - 4 \text{ milliamps}}{20 - 4} \times 100\% = 12.5\%$$

So the Plant Gain is:

$$C = \frac{33.3}{12.5} = 2.66$$

Once R and C are calculated, the proportional and integral bands can be determined as follows:

$$\text{Proportional band (\%)} = P = 286 \frac{C}{R}$$

$$\text{Integral Time (seconds per repeat)} = I = 3.33 \times D \times C$$

So for the example:

$$P = \frac{286\ (2.66)}{3} = 254\%$$

$$I = 3.33\ (4 \text{ sec.})\ 2.66 = 36 \text{ seconds}$$

To enter these parameters, use the procedure detailed in Section 7.6.

## 11.2 TIME PROPORTIONAL CONTROL (TPC) MODE (Code -20)

In the TPC mode, you must establish the following parameters which will determine how the Model 54eA controller responds to your system (see Section 7.7):

- Setpoint
- Time period
- URV point (or 100% on)
- LRV point (or 0% on)
- Proportional
- Integral
- Derivative

The following describes how TPC works. In the example, pH is to be controlled.

The setpoint is the pH you want to control the process to. Time period is programmed in seconds and defines the interval during which the controller compares the pH input from the sensor with the setpoint. In the TPC mode the controller divides the period up into pump on-time (feed time) and pump off-time (blend time).

The URV setting determines how far the pH must deviate from the setpoint to get the pump to be on for the entire period. The LRV setting determines how close the pH must be to the setpoint for the pump to be off for the entire period. The LRV setting should always be set at zero. When the error (the pH minus the setpoint) is between the URV and LRV values, the relay will be energized for some portion of the time period. As the pH value approaches the setpoint, the pump will be feeding for shorter and shorter intervals, and the chemicals will be allowed to mix for longer and longer intervals of the period. This relationship is illustrated in Figure 11-2.

The exact amount of on time and off time per period is determined by the settings for proportional, integral, and derivative bands. The proportional band (P) in % is a separate adjustment that narrows (or widens) the range of the TPC 0-100% action. Smaller values are used for more control response. For a setpoint of 7 pH, a URV of 2 pH, and P=100%, a pH reading of 8 would result in a relay on (8-7)/((2-0)*(100%)) or 50% of the time. If P was changed to 50%, the same relay would be on (8-7)/((2-0)*50%) or 100% of the time.

The integral band is set in seconds and acts to increase the controller output as more time is spent away from the setpoint. A smaller value in seconds will result in faster integration response. Too low a value will result in excess oscillation.

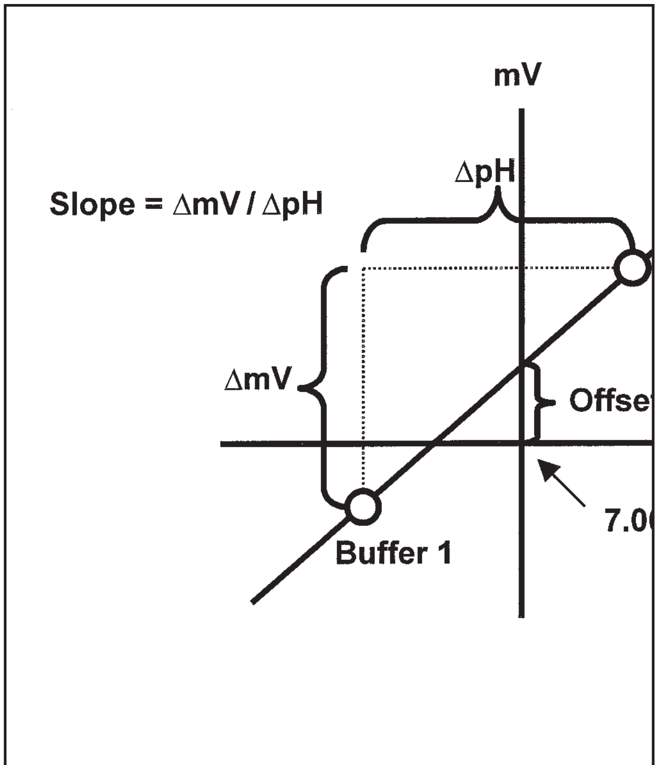



**FIGURE 11-2. Time Proportional Control**

The derivative band is set in % and acts to prevent changes in the reading. This setting should generally be set to zero for pH applications.

TPC offers precise control by forcing the pump to feed chemical for shorter periods of time as you approach the desired setpoint. If the process faces a large upset, TPC mode forces the pump to feed chemical for longer periods of time as the process deviates further from the setpoint. This action continues until the pump is feeding all the time, providing a speedy recovery from large up-sets.

The controller can be programmed to be direct or reverse acting, depending on the pH (or temperature) value selected for URV. For example, if the controller is direct acting based on pH, such as in caustic chemical addition control, the pH will rise as chemical is added, so the URV value will be below the LRV (i.e. below zero). As the pH rises toward the control point value, the pump will be on for gradually less time. Conversely, if the controller is reverse-acting based on pH, such as in acid addition for control, the pH will drop as acid is added, and the URV value will be positive. The pH will fall toward the control point value, and the pump will be on for gradually less time.

Complete TPC configuration is explained and typical settings for these parameters are listed in Section 7. After startup, the operator needs to adjust only the 0% On to maintain the desired chemical concentration.

# SECTION 12
# MAINTENANCE

## 12.1 1055 ANALYZER

The 54eA analyzer requires little routine maintenance.

Clean the controller case and front panel by wiping with a clean soft cloth dampened with water ONLY. Do not use solvents, like alcohol, that might cause a buildup of static charge.

See Figure 12-1, Figure 12-2, and Table 12-1 for replacement parts.

**TABLE 12-1. Replacement Parts for 54eA controller**

| Location in Figure 12-1 | PN | Description |
|---|---|---|
| 1 | 33281-00 | Hinge pin |
| 2 | 23849-00 | Half shield for power supply |
| 3 | 23848-00 | Shield for power supply circuit board |
| 4 | 23969-02 | CPU and power supply boards, calibrated, 115/230 Vac (note) |
| 4 | 23969-06 | CPU and power supply boards, calibrated, 24Vdc (note) |
| 5 | 33293-00 | Enclosure, rear |
| 6 | 23540-05 | Front panel with keyboard |
| 7 | 33286-00 | Gasket, front panel |
| 8 | 9010377 | Display, back-lit, LCD dot matrix |

***Note:*** *The CPU and power supply boards are available only as a calibrated pair. The individual boards cannot be ordered separately.*

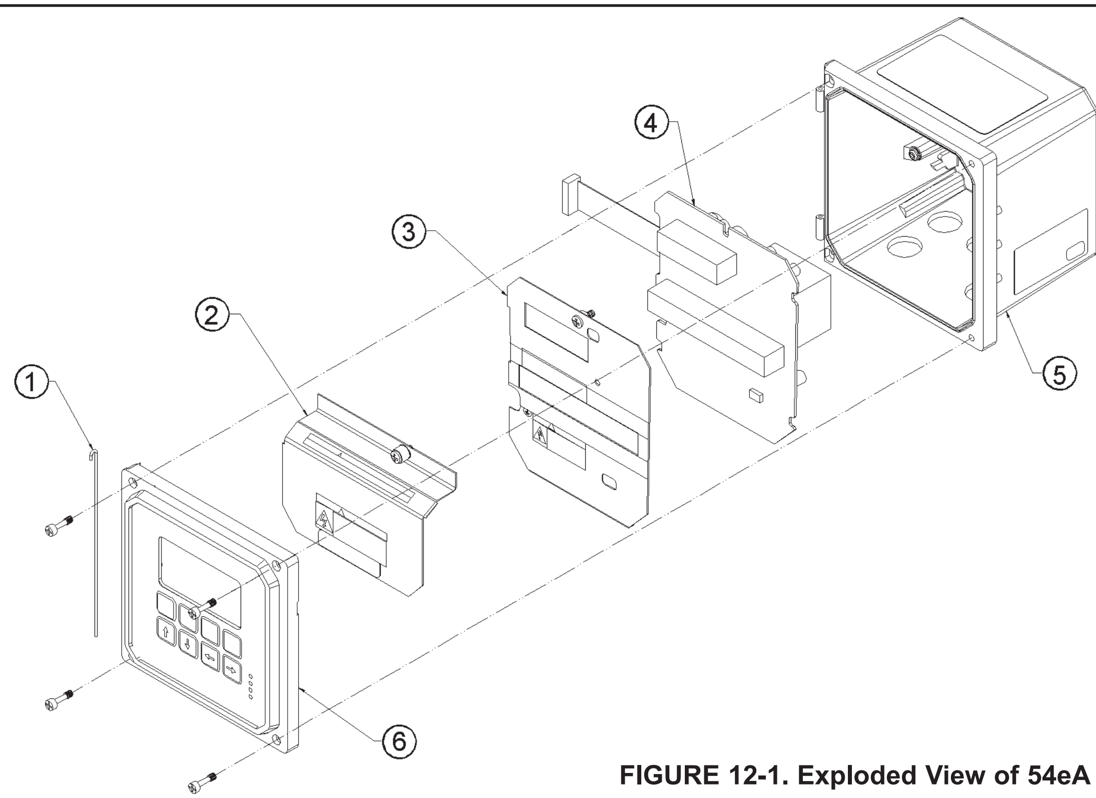



**FIGURE 12-1. Exploded View of 54eA controller**

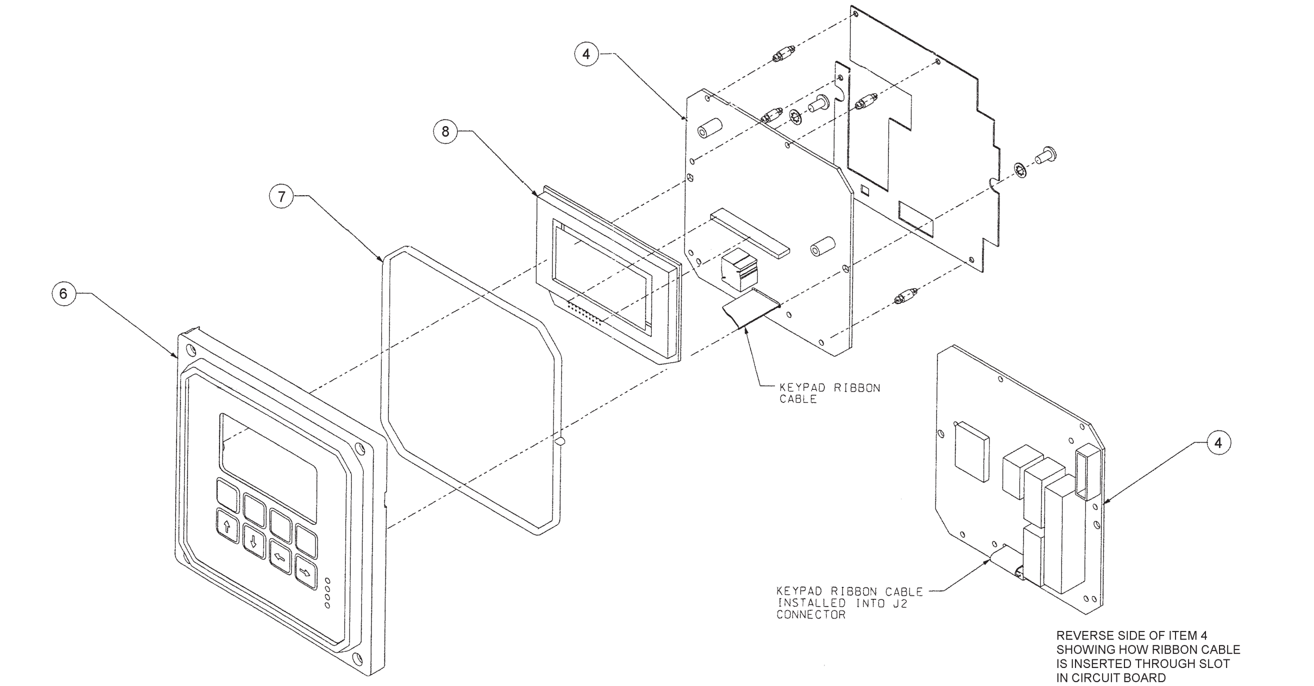



**FIGURE 12-2. Detail of Front Panel of 54eA Controller**

## 12.2 TOTAL CHLORINE SENSOR

### 12.2.1 General

When used in clean water, the total chlorine sensor requires little maintenance. Generally, the sensor needs maintenance when the response becomes sluggish or noisy or when readings drift follow calibration. Maintenance frequency is best determined by experience. If the sensor is a used in potable water, expect to clean the membrane every month and replace the membrane and electrolyte solution every three months. Sensors used in dirty water require more frequent maintenance and calibration. However, if experience shows the sensor is holding calibration and not drifting appreciably between calibration intervals, the maintenance interval can be extended.

### 12.2.2 Cleaning the membrane.

Keep the membrane clean. Clean the membrane with water sprayed from a wash bottle. Use a soft tissue to **gently** wipe the membrane.

### 12.2.3 Replacing the membrane.

1. Hold the sensor with the membrane facing up.
2. Unscrew membrane retainer. Remove the membrane assembly and O-ring. See Figure 12-3.
3. Inspect the cathode. If it is tarnished, clean it by gently rubbing in the direction of the existing scratches (do not use a circular motion) with 400-600 grit silicon carbide finishing paper. Rinse the cathode thoroughly with water.
4. Put a new O-ring in the groove. Hold the membrane assembly with the cup formed by the membrane and membrane holder pointing up. Fill the cup with electrolyte solution.
5 Next, place a drop of electrolyte solution on the cathode. Invert the membrane assembly and place it over the cathode stem.
6. Screw the membrane retainer back in place.
7. Hold the sensor with the membrane pointing down. Shake the sensor a few times, as though shaking down a clinical thermometer.

### 12.2.5 Replacing the membrane and electrolyte solution.

**CAUTION**

Fill solution may cause irritation.
Avoid contact with skin and eyes.
May be harmful if swallowed.

1. Unscrew the membrane retainer and remove the membrane assembly and O-ring. See Figure 12-3.
2. Hold the sensor over a container with the cathode pointing down.
3. Remove the fill plug and allow the electrolyte solution to drain out.
4. Wrap the plug with several turns of pipe tape and set aside.
5. Prepare a new membrane. Hold the membrane assembly with the cup formed by the membrane and membrane holder pointing up. Fill the cup with electrolyte solution.

6. Hold the sensor at about a 45-degree angle with the cathode end pointing up. Add electrolyte solution (see Section 12.2.4) through the fill hole until the liquid overflows. Tap the sensor near the threads to release trapped air bubbles. Add more electrolyte solution if necessary.
7. Place the fill plug in the electrolyte port and begin screwing it in. After several threads have engaged, rotate the sensor so that the cathode is pointing up and continue tightening the fill plug. Do not overtighten.
8. Place a new O-ring in the groove around the cathode post. Cover the holes at the base of the cathode stem with several drops of electrolyte solution.
9. Insert a small **blunt** probe, like a toothpick with the end cut off, through the pressure equalizing port. See Figure 12-3.

   **NOTE**

   **Do not use a sharp probe. It will puncture the bladder and destroy the sensor.**

   Gently press the probe against the bladder several times to force liquid through the holes at the base of the cathode stem. Keep pressing the bladder until no air bubbles can be seen leaving the holes. Be sure the holes remain covered with electrolyte solution.
10. Place a drop of electrolyte solution on the cathode, then place the membrane assembly over the cathode. Screw the membrane retainer in place.
11. The sensor may require several hours operating at the polarizing voltage to equilibrate after the electrolyte solution has been replenished.

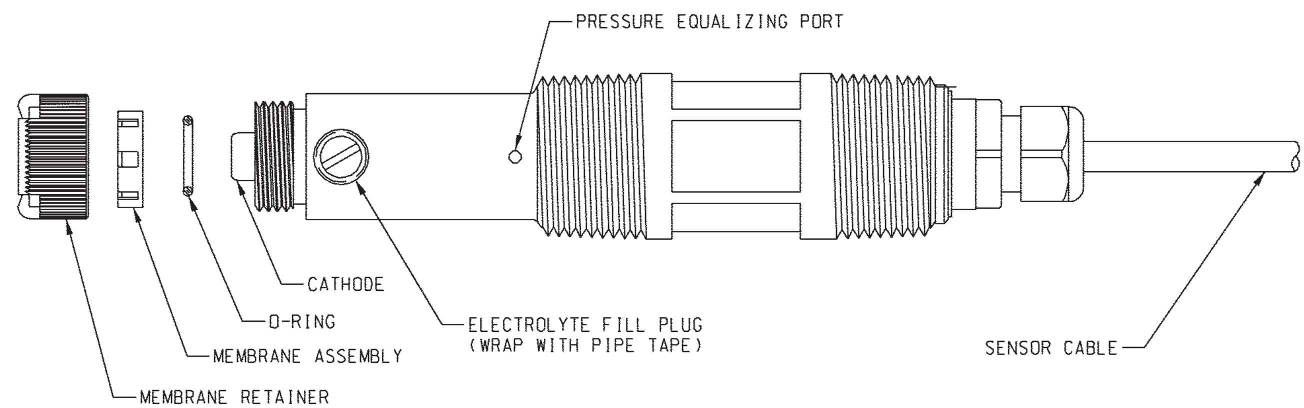



**FIGURE 12-3. Sensor Parts**

**TABLE 12-3. Spare Parts**

| | |
|---|---|
| 33523-00 | Electrolyte Fill Plug |
| 9550094 | O-Ring, Viton 2-014 |
| 33521-00 | Membrane Retainer |
| 23501-02 | Total Chlorine Membrane Assembly: includes one membrane assembly and one O-ring |
| 23502-02 | Total Chlorine Membrane Kit: includes 3 membrane assemblies and 3 O-rings |
| 9210438 | Total Chlorine Sensor Fill Solution, 4 oz (120 mL) |

## 12.3 SAMPLE CONDITIONING SYSTEM

### 12.3.1 Reagent

The sample conditioning reagent lasts about 2 months. Before putting fresh reagent in the carboy, discard any small amount of remaining reagent. To prepare the reagent refer to the procedure in Section 5.1. See Table 12-4 for ordering information.

### 12.3.2 Sample and reagent tubing.

Periodically inspect sample and reagent tubing for cracks and leaks. Replace tubing if it is damaged.

After a period of time, the sample tubing may become plugged with suspended matter. The tubing is flexible and difficult to clean mechanically. Plugged sample tubing is best replaced.

Replacement tubing kits are available. See Table 12-4 for part numbers.

To replace reagent tubing:

1. Reagent tubing is shown in Figure 12-4.
2. Turn off sample and reagent pumps.
3. Luer fittings connect the reagent tubing to the pump. Disconnect the tubing by turning the fitting in the direction of the arrows shown in Figure 12-6.
4. Disconnect the other end of the suction tubing from the barb on the reagent inlet fitting in the bottom of the enclosure. Disconnect the other end of discharge tubing from the reagent injection tee.
5. Install the replacement tubing. Note that the discharge tubing is longer than the suction tubing.

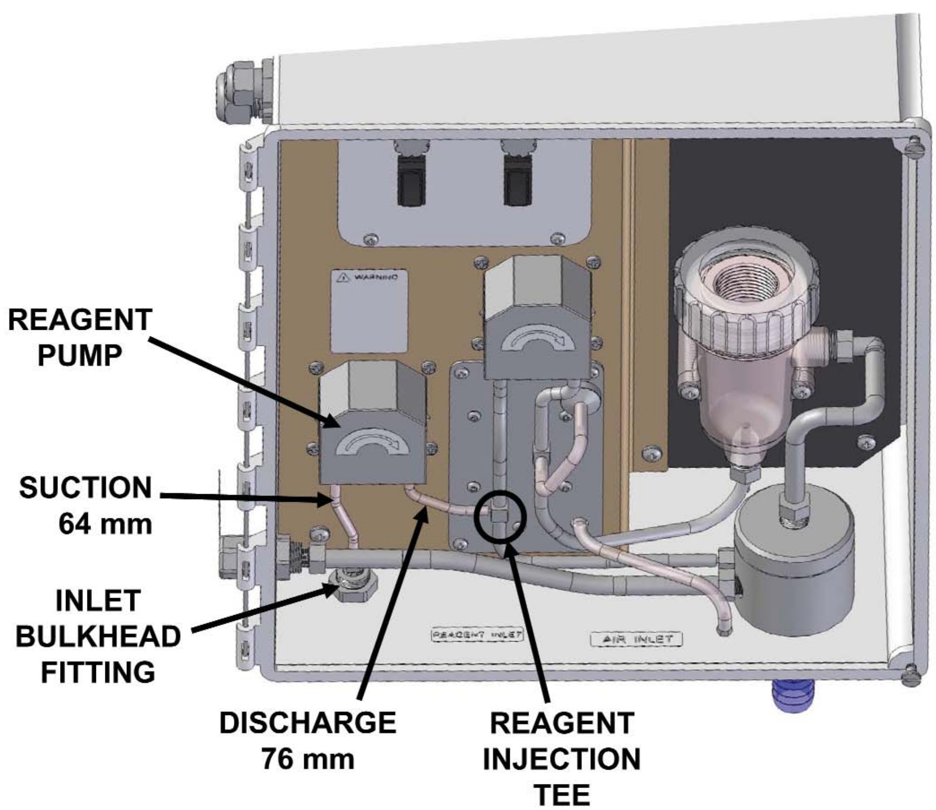



**FIGURE 12-4. Replacing Reagent Tubing**

To replace sample tubing:

1. Sample tubing is shown in Figure 12-5.
2. Turn off the sample and reagent pumps.
3. Luer fittings connect the sample tubing to the pump. Disconnect the tubing by turning the fitting in the direction of the arrows shown in Figure 12-6.
4. Disconnect the other end of the sample pump suction tubing from the overflow sampler. Pull the reagent injection tube off the reagent injection tee.
5. Disconnect the other end of the sample pump discharge tubing from the flow cell. Pull the air injection tube off the air injection tee.
6. Disconnect the sample inlet and drain tubing.
7. Install the replacement sample pump suction and discharge tubing assemblies. The assemblies look similar. To tell the difference, note the air injection tee in the discharge tubing assembly has a larger diameter barb than the reagent injection tee in the suction tubing assembly.
8. Install replacement sample inlet and drain tubing. The sample inlet tubing is longer than the drain tubing.

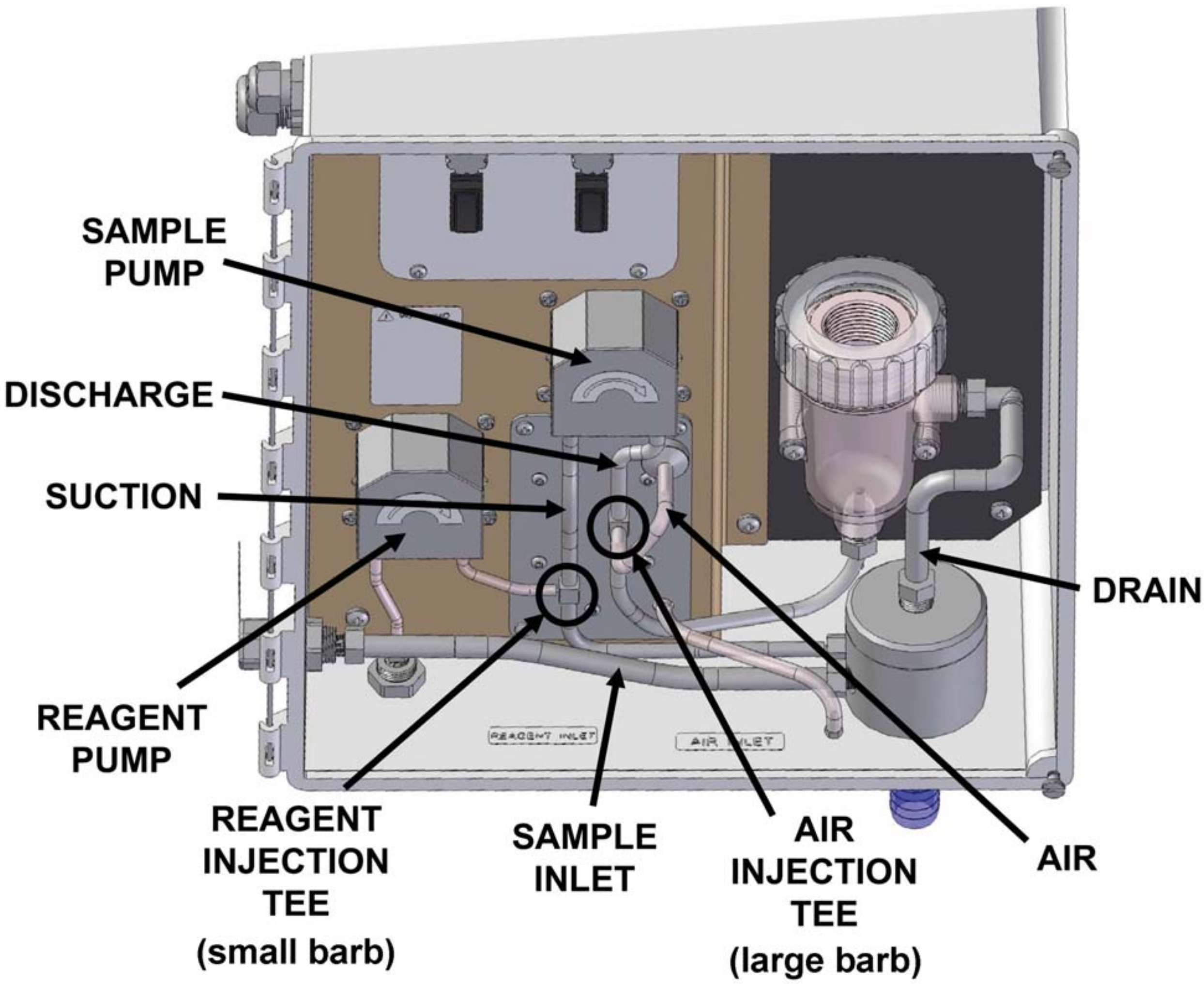



**FIGURE 12-5. Replacing Sample Tubing**

### 12.3.3 Peristaltic pump tubing.

The expected life of the peristaltic pump tubing is one year.

To replace pump tubing:

1. Turn off the sample and reagent pumps.
2. The reagent and sample tubing is connected to the pump tubing with luer fittings. See Figure 12-6. Disconnect the fittings from the pump by turning the fitting in the direction of the arrow.

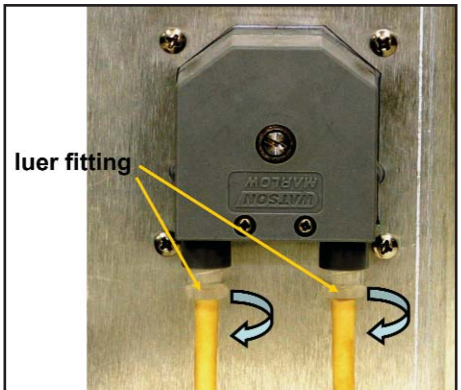



FIGURE 12-6.

3. Using your thumb and forefinger gently pinch the sides of the pump cover. Slide the cover upwards to remove it. See Figure 12-7.

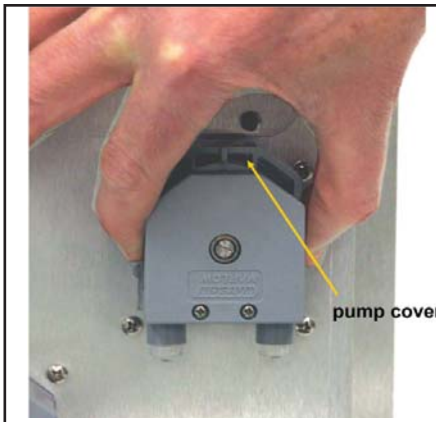



FIGURE 12-7.

4. Using your thumb as shown in Figure 12-8, push the tubing fitting straight outward until the fitting slides out of the socket. Repeat the process for the other fitting.
5. Remove and discard the pump tubing.

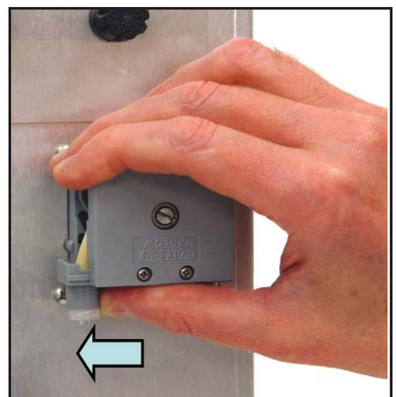


FIGURE 12-8.

6. Insert the new tubing one end at a time. Tongues on the sides of the gray fittings at the ends of the tube fit into receiving grooves in the pump casing. See Figure 12-9. Push the fitting into place until it clicks. Gently stretch the tubing over the rollers and insert the other fitting into the receiving socket on the other side of the pump.

FIGURE 12-9.

7. Replace the pump cover.
   a. Place the cover on the pump casing. See Figure 12-10.

FIGURE 12-10.

   b. Be sure the pins at the bottom of the cover (Figure 12-11) ride on the tracks in the pump casing.

FIGURE 12-11.

   c. The position of the track is outlined in Figure 12-12. The pins on the pump cover must ride in these tracks as the cover is pushed into place. Gently squeeze the ends of the cover to guide the pins.

FIGURE 12-12.

   d. Push down until the cover snaps into place.

8. Reconnect the tubing.

### 12.3.4 Replacing the air pump

1. Disconnect power to the analyzer.
2. Refer to Figure 12-13. Disconnect the reagent and air injection tubes. Disconnect the suction and discharge tubing by turning the Luer fitting in the direction shown in the figure. Disconnect the air pump inlet tubing from the barbed fitting in the bottom of the enclosure.
3. Remove the four screws (circled in Figure 12-14) holding the air pump access panel. Pull out the pump and panel.
4. Disconnect the air inlet and outlet tubing from the air pump. See Figure 12-15.
5. Remove the five screws (surrounded by squares in Figure 12-14) holding the air pump to the access panel.
6. Remove the four screws holding the wiring access panel.
7. Disconnect the air pump power wires from the terminal strip. See Figure 12-16. Discard the old air pump.
8. Remove the five screws holding the rubber base of the replacement air pump to the body.
9. Using the five screws removed in step 6, attach the replacement air pump to the access panel.
10. Connect the air pump power wires to the terminal strip.
11. Replace the wiring access panel.
12. Connect the air inlet and outlet tubing to the air pump. See Figure 12-15. The conical end of the check valve points in the direction of the air flow.
13. Replace the air pump access panel.
14. Connect the sample pump tubing to the pump. Connect the reagent and air injection tubing. Connect the air inlet tubing to the barbed fitting at the bottom of the enclosure.

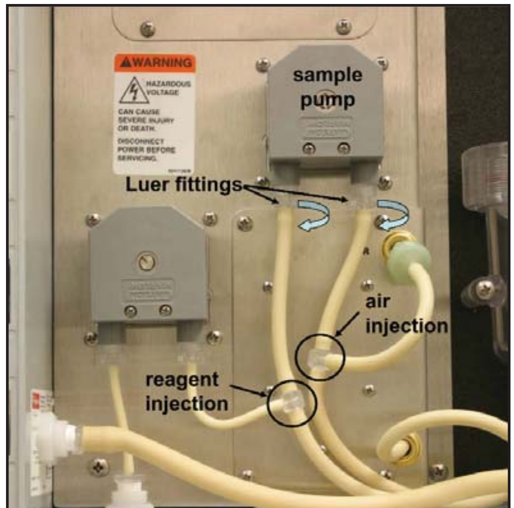



**FIGURE 12-13.**


**FIGURE 12-14.**

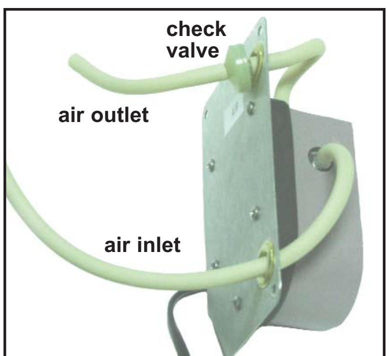



**FIGURE 12-15.**

Model option -11 115 Vac only
Model option -12 230 Vac only

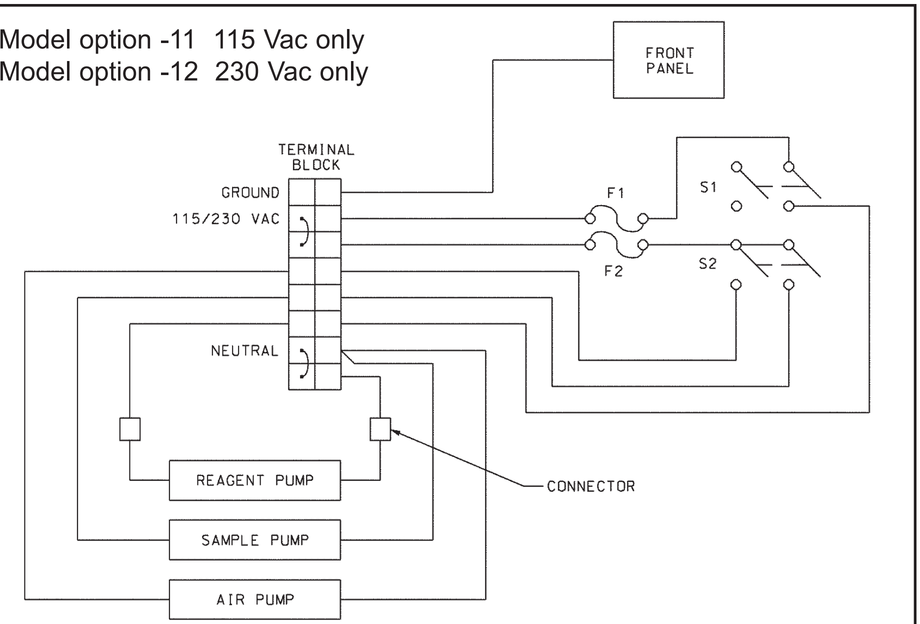



**FIGURE 12-16.**

### 12.3.5 Replacing the air pump diaphragm and check valves.

**WARNING**

**HAZARDOUS VOLTAGE**

**CAN CAUSE SEVERE INJURY OR DEATH.**

**DISCONNECT POWER BEFORE SERVICING.**

9241136/B

1. Disconnect power to the analyzer.
2. Refer to Figure 12-13. Disconnect the reagent and air injection tubes. Disconnect the suction and discharge tubing by turning the Luer fitting in the direction shown in the figure. Disconnect the air pump inlet tubing from the barbed fitting in the bottom of the enclosure.
3. Remove the four screws (circled in Figure 12-14) holding the air pump access panel. Pull out the pump and panel.
4. Disconnect the air inlet and outlet tubing from the air pump. See Figure 12-15.
5. Remove the five screws (surrounded by squares in Figure 12-14) holding the air pump to the access panel.
6. Pull the rubber base off the pump.
7. Using needle nose pliers, remove the air inlet fitting from the side of the air pump. See Figure 12-17.
8. Slide the pump assembly out of the air pump body. See Figure 12-18.
9. Following instructions on the package (PN 9160518), replace the diaphragm and check valves.
10. Slide the pump assembly back into the pump body and replace the barbed inlet fitting.
11. Replace the rubber base and screw the pump access panel back onto the air pump.
12. Connect the air inlet and outlet tubing to the air pump. See Figure 12-15. The conical end of the check valve points in the direction of the air flow.
13. Replace the air pump access panel.
14. Connect the sample pump tubing to the pump. Connect the reagent and air injection tubing. Connect the air inlet tubing to the barbed fitting at the bottom of the enclosure.

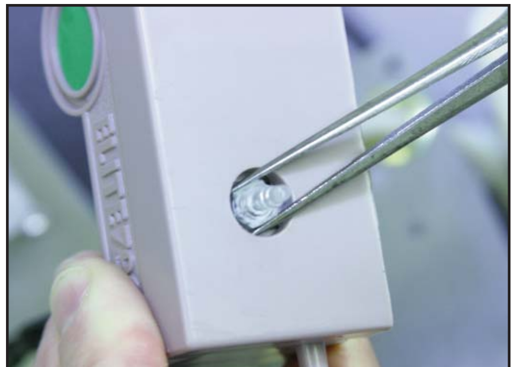


**FIGURE 12-17.**

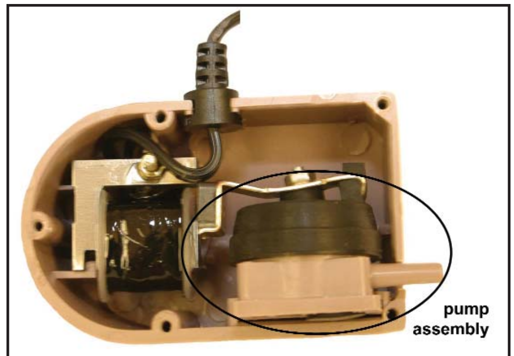



**FIGURE 12-18.**

**TABLE 12-4. Replacement Parts and Reagent for Sample Conditioning System**

| PN | Description |
|---|---|
| 24134-00 | Air pump, 115 Vac, 60 Hz |
| 24134-01 | Air pump, 230 Vac, 50 Hz |
| 9160578 | Air pump repair kit |
| 9322052 | Check valve for air injection line |
| 24153-00 | Carboy for reagent, 5 gal/19 L, includes cap |
| 9100204 | Fuse, 0.25 A, 250 V, 3AG, slow blow for option -11 (115 Vac) |
| 9100132 | Fuse, 0.125 A, 250 V, 3AG, slow blow for option -12 (230 Vac) |
| 9380094 | Reagent pump, 115 Vac, 50/60 Hz |
| 9380095 | Reagent pump, 230 Vac, 50/60 Hz |
| 9380091 | Reagent pump replacement tubing |
| 24151-00 | Reagent tubing replacement kit (see Section 12.3.2) |
| 24135-00 | Reagent uptake tubing, 6 ft (1.8 m), includes weight |
| 9380090 | Sample pump, 115 Vac, 50/60 Hz |
| 9380093 | Sample pump, 230 Vac, 50/60 Hz |
| 9380092 | Sample pump replacement tubing |
| 24152-00 | Sample tubing replacement kit (see Section 12.3.2) |

| PN | Description |
|---|---|
| 24165-00 | Acetic acid, 2 x 2.5 gal (9.5 L) bottles/case, with 25 g potassium iodide |
| 24165-01 | Acetic acid, 2 x 2.5 gal (9.5 L) bottles/case, with 50 g potassium iodide |
| 24164-00 | Potassium iodide, 25 g, sufficient for 5 gallons (19 L) of vinegar (for 0-5 ppm total chlorine) |
| 24164-01 | Potassium iodide, 50 g, sufficient for 5 gallons (19 L) of vinegar (for 0-10 ppm total chlorine) |

# SECTION 13.
# TROUBLESHOOTING

## 13.1 OVERVIEW

The Solu Comp II continuously monitors itself and the sensor for faults. When the analyzer detects a fault, the word *fault* appears in the display alternately with the measurement. If alarm 3 was configured as a fault alarm, the alarm relay will energize. The outputs do not change during a fault condition. They continue to reflect the measured chlorine or temperature. **Press ▲ to display the fault codes.**

A large number of information screens are available to aid troubleshooting. The most useful of these are raw sensor current and sensitivity and zero current at last calibration. To view the information screens, go to the main display and press the ▼ key.

## 13.2 TROUBLESHOOTING USING FAULT CODES

| Fault Code | Explanation | See Section |
|---|---|---|
| S1 Out of Range | Sensor current exceeds 210 µA (chlorine only) | 13.2.1 |
| TC1 Open | RTD is open | 13.2.2 |
| TC1 Shorted | RTD is shorted | 13.2.2 |
| S1 Sense Line Open | RTD sense line is open | 13.2.3 |
| EEPROM Failure | EEPROM failure | 13.2.4 |

### 13.2.1 Sensor Current Exceeds 210 µA

Excessive sensor current implies that the sensor is miswired or the membrane is torn. It can also mean the sensor has failed.

### 13.2.2 RTD is Open or Shorted.

There is an open or short in the sensor RTD or wiring.

A. If sensor is being installed for the first time, check the wiring connections. See Section 4.3.

B. Disconnect the sensor from the analyzer and measure the resistance between the RTD lead wires. See the sensor manual to identify the RTD leads. If there is an open or short circuit, replace the sensor.

C. If there is no open or short, check the analyzer. See Section 13.5

### 13.2.3 RTD Sense Line is Open.

The Solu Comp II measures temperature using a three-wire RTD. See Figure 13-3. The in and return leads connect the RTD to the measuring circuit in the analyzer. A third wire, called the sense line, is connected to the return line. The sense line allows the analyzer to correct for the resistance of the in and return leads and to correct for changes in lead wire resistance caused by changes in ambient temperature.

A. Verify that all wiring connections are secure.

B. The analyzer can be operated with the sense line open. The measurement will be less accurate because the analyzer can no longer correct for lead wire resistance and for changes in lead wire resistance with ambient temperature. However, if the sensor is to be used at approximately constant temperature, the lead wire resistance error can be eliminated by calibrating the sensor at the measurement temperature. Errors caused by changes in lead wire resistance with changes in ambient temperature cannot be eliminated.To make the error message disappear, connect the RTD sense and return terminals with a jumper.

### 13.2.4 EEPROM Failure.

EEPROM failure means the analyzer is unable to store data in the non-volatile memory. Thus, if power is lost then restored, all configurations and calibrations will be lost. Call the factory for assistance. The analyzer will probably need to be replaced.

## 13.3 TROUBLESHOOTING WHEN NO ERROR MESSAGE IS SHOWING

| Problem | See Section |
|---|---|
| Zero current was accepted, but the current is outside the range -10 to 50 nA | 13.3.1 |
| Error or warning message appears while zeroing the sensor (zero current is too high) | 13.3.1 |
| Zero current is unstable | 13.3.2 |
| Sensor can be calibrated, but current is low | 13.3.3 |
| Process readings are erratic or wander | 13.3.4 |
| Readings drift | 13.3.5 |
| Readings are too high | 13.3.6 |
| Readings are too low | 13.3.3 |
| Calibration temperature more than 3°C different from standard thermometer | 13.3.7 |
| Current output is too low | 13.3.8 |
| Alarm relays do not operate when setpoint is exceeded or do not release when reading is below setpoint | 13.3.9 |
| Display too light or dark | 13.3.10 |

### 13.3.1 Zero current is too high

A. Is the sensor properly wired to the analyzer? See Section 4.3.

B. Is the zero solution chlorine free? Take a sample of the zero solution and test it for total chlorine. The concentration should be less than 0.05 ppm. Avoid using tap water for zeroing the sensor. Even though the tap water contains no iodine, chlorine oxidants present in the tap water may produce a sensor current as high as 100 nA.

C. Has adequate time been allowed for the sensor to reach a minimum stable zero current? It may take several hours, sometimes as long as overnight, for a new sensor to stabilize.

D. Is the sensor fill solution fresh? An old, discolored fill solution may produce a high zero current.

E. Is the membrane damaged? Inspect the membrane and replace it if necessary.

### 13.3.2 Zero current is unstable

A. Is the sensor properly wired to the analyzer? See Section 4.3. Verify that all connections are tight.

B. Readings can be erratic when a new sensor is first placed in service. Readings usually stabilize over about an hour.

C. Is the space between the membrane and cathode filled with electrolyte solution and is the flow path between the electrolyte reservoir and membrane clear? Often the flow of electrolyte can be started by simply holding the sensor with the membrane end pointing down and sharply shaking the sensor a few times as though shaking down a clinical thermometer.

   If shaking does not work, try clearing the holes around the cathode stem. Hold the sensor with the membrane end pointing up. Unscrew the membrane retainer and remove the membrane assembly. Use the end of a straightened paper clip to clear the holes at the base of the cathode stem.

   Verify the sensor is filled with electrolyte solution. Refer to Section 12.2.

### 13.3.3 Sensitivity is low or readings are low

A. Does the reagent carboy contain reagent? Is the reagent uptake tubing below the level of the reagent? Has potassium iodide been added to the acetic acid (vinegar) reagent?

B. Is there adequate flow to the overflow sampler? Excess sample should be flowing down the inside tube of the flow controller.

C. Does the reagent contain the correct amount of potassium iodide? See the table.

| Expected range, ppm as Cl2 | Amount of KI needed per 5 gallons of vinegar | Part number |
|---|---|---|
| 0 – 5 ppm | 25 grams | 24164-00 |
| 0 – 10 ppm | 50 grams | 24164-01 |
| 0 – 20 ppm | 2 x 50 grams | 24164-01 |

D. Was the comparison or calibration sample tested as soon as it was taken? Chlorine solutions can be unstable. Test the sample immediately after collecting it. Avoid exposing the sample to sunlight.

E. Is the membrane fouled or coated? A dirty membrane inhibits diffusion of iodine through the membrane, reducing sensor current. Clean the membrane by rinsing it with a stream of water from a wash bottle. Wipe gently with a soft tissue.

F. Are the reagent and sample pumps running? If a pump is not running, check the fuse and replace it if necessary. See Table 12-4 for part numbers. If the fuse is okay, replace the pump.

G. Are all tube fittings tight? Pay particular attention to the luer fittings that connect the tubing to the pumps.

H. Does the pump tubing element need replacing? Remove the tubing from the pump and inspect it. If the tubing appears permanently pinched or deformed, replace the tubing. Refer to Section 12.3.4 for instructions on how to remove and replace the tubing elements. The expected life of a tubing element is about one year.

I. Is the sample flow to the sensor about 11 mL/min? If the sample flow is too low, the total chlorine reading will be low. If the flow is too high, the ratio between the sample flow and reagent flow will be too high, and there might be insufficient reagent to properly react with the total chlorine in the sample. To check sample flow…

1. Turn off the reagent and sample pumps.
2. Disconnect the luer fitting on the discharge of the sample pump. See **A** in Figure 13-1.
3. Hold a small beaker under the discharge port.
4. Start the sample pump and collect sample for two minutes.
5. Measure the volume of sample collected in the beaker. After two minutes, the volume should be about 22 mL.

J. Is the reagent flow about 0.2 mL/min? If the reagent flow is too low, there might be insufficient acetic acid to lower the sample pH and insufficient potassium iodide to react with total chlorine in the sample. To check reagent flow…

1. Turn off the reagent and sample pumps.
2. Disconnect the reagent tubing at the injection tee. See **B** in Figure 13-1.
3. Place the end of the tubing in a 5 mL graduated cylinder.
4. Start the reagent pump and collect reagent for ten minutes.
5. Note the volume of reagent collected in the graduated cylinder. After ten minutes the volume should be about 2 mL.

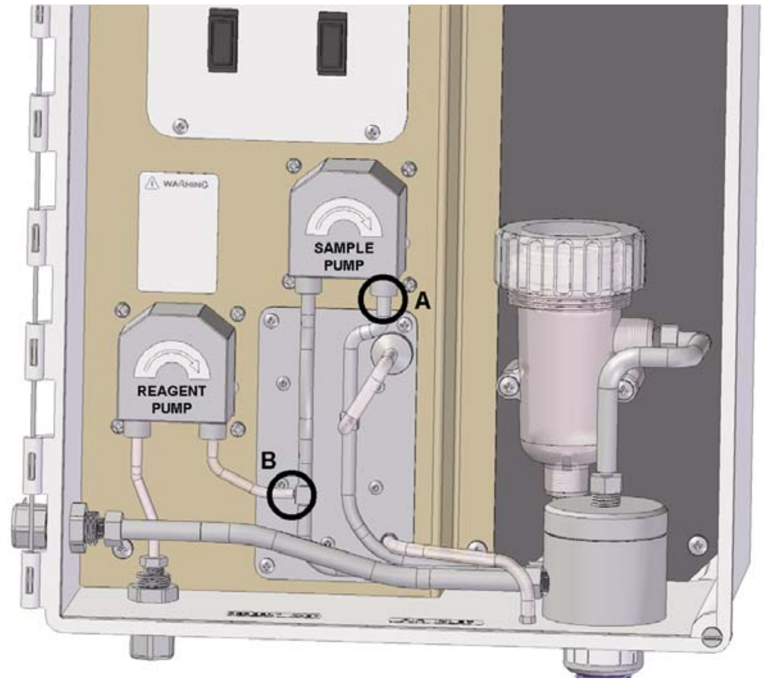



**FIGURE 13-1. Disconnecting sample (A) and reagent (B) tubing prior to checking flow.**

### 13.3.4 Process readings are erratic or wander

A. Is the sensor properly wired to the analyzer? See Section 4.3. Verify that all connections are tight.

B. Readings can be erratic when a new sensor is first placed in service. Readings usually stabilize aver about an hour.

C. Is the air pump working? There should be a vigorous stream of bubbles in the flow cell. The bubbles help mix the sample and keep carbon dioxide bubbles off the membrane. Carbon dioxide forms when bicarbonate alkalinity in the sample reacts with acetic acid. The bubbles accumulate on the membrane and eventually break away, causing total chlorine reading to wander.

D. Is the membrane damaged or loose? Replace the membrane if necessary.

D. Is the space between the membrane and cathode filled with electrolyte solution and is the flow path between the electrolyte reservoir and membrane clear? Refer to Section 13.3.2C for more information.

### 13.3.5 Readings drift

A. Is the sample temperature changing? Membrane permeability is a function of temperature. The time constant for the 499ACL-01sensor is about five minutes. Therefore the reading may drift for a while after a sudden temperature change.

B. Is the membrane clean? For the sensor to work properly, iodine must diffuse freely through the membrane. A coating on the membrane will interfere with the passage of iodine, resulting in a gradual downward drift in readings. The coating will also slow the response on the sensor to step changes. Clean the membrane by rinsing is with a stream of water from a wash bottle. Wipe the membrane with a soft tissue.

C. Is the sensor new or has it recently been serviced? New or rebuilt sensors may require several hours to stabilize.

D. Is the flow of sample past the sensor about 11 mL/min? See Section 13.3.3D for more information.

E. Is the reagent flow about 0.2 mL/min? See Section 13.3.3E for more information.

### 13.3.6 Readings are too high

A. Is the sample conditioning reagent clear and colorless? If the reagent is pale yellow, results will be high. The pale yellow color is caused by iodine, which comes from the reaction between atmospheric oxygen and potassium iodide. The reaction is catalyzed by sunlight. The purpose of the blue carboy is to protect the reagent from sunlight.

B. Is the sensor fill solution fresh? An old, discolored fill solution may produce a high reading.

### 13.3.7 Temperature measured by standard thermometer was more than 3°C different from analyzer.

A. Is the standard thermometer, RTD, or thermistor accurate? General purpose liquid-in-glass thermometers, particularly ones that have been mistreated, can have surprisingly large errors.

B. Is the temperature element in the sensor completely submerged in the liquid?

C. Is the standard temperature sensor submerged to the correct level?

### 13.3.8 Current Output Too Low.

Load resistance is too high. Maximum load is 600 Ω.

### 13.3.9 Alarm Relays Do Not Work

A. Verify the relays are properly wired.

B. Check the alarm hysteresis. See Section 7.7.

### 13.3.10 Display is Too Light or Dark.

Adjust contrast. See Section 7.5.

## 13.4 SIMULATING INPUTS

To check the performance of the analyzer, use a decade box and battery to simulate the current from the sensor. The battery, which opposes the polarizing voltage, is necessary to ensure that the sensor current has the correct sign.

A. Disconnect the anode and cathode leads from terminals 1 and 2 on TB3 and connect a decade box and battery as shown in Figure 13-2. It is not necessary to disconnect the RTD leads.

B. Set the decade box to the resistance shown below.

| Polarizing Voltage | Resistance | Expected Current |
|---|---|---|
| 200 mV | 2.8 MΩ | 500 nA |

C. Note the sensor current. It should be close to the value in the table. The actual value depends on the voltage of the battery. To view the sensor current, go to the main display and press ▼ until the sensor current is displayed.

D. Change the decade box resistance and verify that the correct current is shown. Calculate current from the equation:

$$\text{current (nA)} = \frac{V_{battery} - V_{polarizing}\ \text{(mV)}}{\text{resistance (M}\Omega\text{)}}$$

The voltage of a fresh 1.5 volt battery is about 1.6 volt (1600 mV).

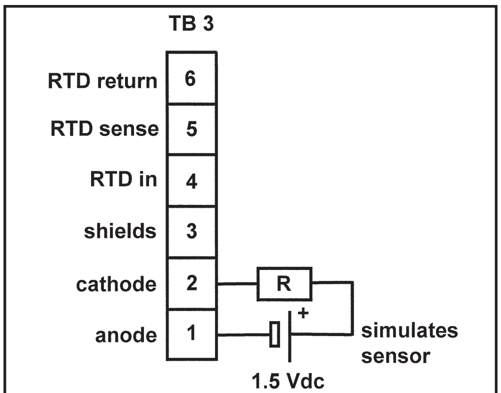


FIGURE 13-2. Simulating Chlorine

## 13.5 SIMULATING TEMPERATURE

### 13.5.1 General.

The 54eA controller accepts either a Pt100 RTD (for pH and chlorine sensors). The Pt100 RTD is in a three-wire configuration. See Figure 13-3.

### 13.5.2 Simulating temperature

To simulate the temperature input, wire a decade box to the analyzer or junction box as shown in Figure 13-4.

To check the accuracy of the temperature measurement, set the resistor simulating the RTD to the values indicated in the table and note the temperature readings. The measured temperature might not agree with the value in the table. During sensor calibration an offset might have been applied to make the measured temperature agree with a standard thermometer. The offset is also applied to the simulated resistance. The Solu Comp II is measuring temperature correctly if the difference between measured temperatures equals the difference between the values in the table to within ±0.1°C.

For example, start with a simulated resistance of 103.9 Ω, which corresponds to 10.0°C. Assume the offset from the sensor calibration was -0.3 Ω. Because of the offset, the analyzer calculates temperature using 103.6 Ω. The result is 9.2°C. Now change the resistance to 107.8 Ω, which corresponds to 20.0°C. The analyzer uses 107.5 Ω to calculate the temperature, so the display reads 19.2°C. Because the difference between the displayed temperatures (10.0°C) is the same as the difference between the simulated temperatures, the analyzer is working correctly.

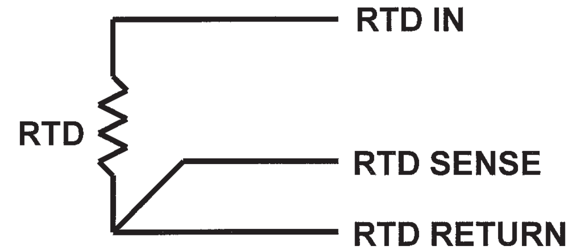



**FIGURE 13-3. Three-Wire RTD Configuration.**

Although only two wires are required to connect the RTD to the analyzer, using a third (and sometimes fourth) wire allows the analyzer to correct for the resistance of the lead wires and for changes in the lead wire resistance with temperature.

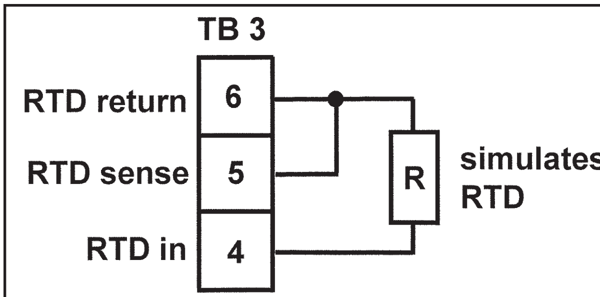



**FIGURE 13-4. Simulating RTD Inputs.**

| Temp. (°C) | Pt 100 (Ω) |
|---|---|
| 0 | 100.0 |
| 10 | 103.9 |
| 20 | 107.8 |
| 25 | 109.7 |
| 30 | 111.7 |
| 40 | 115.5 |
| 50 | 119.4 |
| 60 | 123.2 |
| 70 | 127.1 |
| 80 | 130.9 |
| 85 | 132.8 |
| 90 | 134.7 |
| 100 | 138.5 |

# SECTION 14
# RETURN OF MATERIAL

## 14.1 GENERAL.

To expedite the repair and return of instruments, proper communication between the customer and the factory is important. Before returning a product for repair, call 1-949-757-8500 for a Return Materials Authorization (RMA) number.

## 14.2 WARRANTY REPAIR.

The following is the procedure for returning instruments still under warranty:

1. Call Rosemount Analytical for authorization.
2. To verify warranty, supply the factory sales order number or the original purchase order number. In the case of individual parts or sub-assemblies, the serial number on the unit must be supplied.
3. Carefully package the materials and enclose your “Letter of Transmittal” (see Warranty). If possible, pack the materials in the same manner as they were received.
4. Send the package prepaid to:

   Emerson Process Management
   Liquid Division
   2400 Barranca Parkway
   Irvine, CA 92606

   Attn: Factory Repair

   RMA No. ____________

   Mark the package: Returned for Repair

   Model No. ____

**IMPORTANT**

Please see second section of “Return of Materials Request” form. Compliance with the OSHA requirements is mandatory for the safety of all personnel. MSDS forms and a certification that the instruments have been disinfected or detoxified are required.

## 14.3 NON-WARRANTY REPAIR.

The following is the procedure for returning for repair instruments that are no longer under warranty:

1. Call Rosemount Analytical for authorization.
2. Supply the purchase order number, and make sure to provide the name and telephone number of the individual to be contacted should additional information be needed.
3. Do Steps 3 and 4 of Section 14.2.

**NOTE**

Consult the factory for additional information regarding service or repair.

## WARRANTY

Goods and part(s) (excluding consumables) manufactured by Seller are warranted to be free from defects in workmanship and material under normal use and service for a period of twelve (12) months from the date of shipment by Seller. Consumables, pH electrodes, membranes, liquid junctions, electrolyte, O-rings, etc. are warranted to be free from defects in workmanship and material under normal use and service for a period of ninety (90) days from date of shipment by Seller. Goods, part(s) and consumables proven by Seller to be defective in workmanship and / or material shall be replaced or repaired, free of charge, F.O.B. Seller's factory provided that the goods, parts(s), or consumables are returned to Seller's designated factory, transportation charges prepaid, within the twelve (12) month period of warranty in the case of goods and part(s), and in the case of consumables, within the ninety (90) day period of warranty. This warranty shall be in effect for replacement or repaired goods, part(s) and consumables for the remaining portion of the period of the twelve (12) month warranty in the case of goods and part(s) and the remaining portion of the ninety (90) day warranty in the case of consumables. A defect in goods, part(s) and consumables of the commercial unit shall not operate to condemn such commercial unit when such goods, parts(s) or consumables are capable of being renewed, repaired or replaced.

The Seller shall not be liable to the Buyer, or to any other person, for the loss or damage, directly or indirectly, arising from the use of the equipment or goods, from breach of any warranty or from any other cause. All other warranties, expressed or implied are hereby excluded.

IN CONSIDERATION OF THE STATED PURCHASE PRICE OF THE GOODS, SELLER GRANTS ONLY THE ABOVE STATED EXPRESS WARRANTY. NO OTHER WARRANTIES ARE GRANTED INCLUDING, BUT NOT LIMITED TO, EXPRESS AND IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

## RETURN OF MATERIAL

Material returned for repair, whether in or out of warranty, should be shipped prepaid to:

**Rosemount Analytical Inc.**
**Uniloc Division**
**2400 Barranca Parkway**
**Irvine, CA 92606**

The shipping container should be marked:

Return for Repair
Model ___________________________________

The returned material should be accompanied by a letter of transmittal which should include the following information (make a copy of the "Return of Materials Request" found on the last page of the Manual and provide the following thereon):

1. Location type of service, and length of time of service of the device.
2. Description of the faulty operation of the device and the circumstances of the failure.
3. Name and telephone number of the person to contact if there are questions about the returned material.
4. Statement as to whether warranty or non-warranty service is requested.
5. Complete shipping instructions for return of the material.

Adherence to these procedures will expedite handling of the returned material and will prevent unnecessary additional charges for inspection and testing to determine the problem with the device.

If the material is returned for out-of-warranty repairs, a purchase order for repairs should be enclosed.

**Emerson Process Management**

**Liquid Division**
2400 Barranca Parkway
Irvine, CA 92606 USA
Tel: (949) 757-8500
Fax: (949) 474-7250

http://www.raihome.com



EMERSON
Process Management